THURSDAY, SEPTEMBER 9, 1897.

ABELIAN AND THETA FUNCTIONS.

Abel's Theorem and the allied Theory, including the Theory of the Theta Functions. By H. F. Baker, M.A. Pp. xx + 684. (Cambridge: at the University Press, 1897.)

CAYLEY'S often-quoted simile which compares the province of mathematics with "a tract of beautiful country seen at first in the distance, but which will bear to be rambled through and studied in every detail of hillside and valley, stream, rock, wood, and flower," suggests a comparison of mathematical text-books with those useful works which provide information and advice for the tourist and the traveller. It may be said with truth that there is every variety, from the cheap illustrated pamphlet, designed to catch the eye of the holiday tripper in search of the picturesque, to the elaborate maps, surveys, and gazetteers which are best appreciated by the genuine explorer.

It is to the latter class that Mr. Baker's treatise belongs. It is in no sense a book for beginners; in order to appreciate it, the reader must be tolerably familiar with modern function-theory, and not wholly ignorant of the special subject of the work. Even then, he will probably find the treatise most useful as a "hand-book"; that is to say, as a methodical guide to, and commentary upon, the host of memoirs which are ultimately connected with Abel's researches on algebraic integrals. In this respect, the work is sure to be very valuable; for the author has evidently spared no pains in making himself familiar with everything of importance that has been done in this field, and in attaining, so far as possible, an impartial attitude towards the different ways in which the subject has been presented.

The title recalls the fact that not so very long ago "Abel's Theorem" was apt to be regarded by mathematical students as being something like "Taylor's Theorem" or "Ivory's Theorem": a stiff piece of isolated analysis, for which one's "coach" was expected to produce a concise and elegant proof, adapted for writing out in an examination. Even now it may be a surprise to some readers to find that a work professing to deal mainly with Abel's Theorem can extend to nearly seven hundred large and well-filled pages of print. The truth is that while Abel's Theorem is in itself a comparatively simple matter, and is perhaps best regarded as a theorem in symmetric functions, it forms a kind of centre from which several fundamental theories may be said to radiate. In order to give precision to the theorem itself, it is necessary to establish the real nature and properties of algebraic functions; Jacobi's problem of inversion, or, in other words, the introduction of Abelian functions properly so called, leads to the vast and in some ways still mysterious theory of the general theta-functions; these, in their turn, have in late years suggested an almost bewildering variety of transcendental functions; and, finally, we have the reaction of all these discoveries upon analytical geometry. It is therefore not astonishing that Mr. Baker's volume is so large; it would, in fact, have been much larger but for his studied conciseness, which, indeed, here and there, may be thought almost overdone.

In a subject like this, which, perhaps more than any other, has brought out the contrast between the intuitional and analytical schools, it is always interesting to observe an author's point of view. Mr. Baker has adopted a kind of middle course which will commend itself to those whose minds, like Cayley's, while essentially analytical, love to clothe their discoveries in the language of geometry. Thus the real start is made by assuming the existence of Riemann's fundamental integrals of the first, second, and third kind. Of course, after the work of Neumann, Schwarz, and others, there is no logical inconsistency in this; and it is convenient for purposes of exposition. But it is open to two objections: the first is, that the proof of Riemann's existence-theorems is long and difficult, when it is thorough; the second, and more essential, is that algebraic functions present themselves as special collocations of integrals, and are not considered in the first instance on their own merits; it is hard to refrain from thinking that this is, to some extent, putting the cart before the horse.

But it ought in fairness to be said, that in subsequent chapters (iii.–vii.), the analytical theory of Weierstrass, Dedekind, Kronecker, and Hensel is explained in sufficient detail to enable the reader to appreciate the other point of view; although, as a matter of fact, Weierstrass's fundamental "Lückensatz" is deduced from the existence-theorems.

Points which deserve attention in these earlier chapters are the careful explanation of "the places and infinitesimal on a Riemann surface"; the discussion of the Riemann-Roch theorem, which is unusually clear, and well illustrated by examples; and the satisfactory treatment of adjoint polynomials. As to this last point, we cannot but think that the advantage is all on the side of the analytical school. They can explain why, and in what sense, a singular point on a curve is to be reckoned as δ nodes and κ cusps in the calculation of the deficiency; can the intuitional mathematician say what δ and κ ought to be at a higher singularity of a curve described by a definite mechanical process, without finding the equation of the curve?

Chapter viii. dismisses Abel's Theorem in the course of twenty-seven pages. This brief treatment is made possible by what has gone before; still it is rather a pity that more space has not been given to an independent and purely algebraical treatment of at least the differential form of the theorem.

In chapter ix. we are introduced to the inversion problem: and here it is pleasing to find an account of Weierstrass's procedure, which is certainly the most satisfactory in giving an intelligible form to the result, although, of course, it is not a practicable method of solving the problem. For this we must have recourse to the theta-functions, and these are in fact introduced in chapter x. It is with the theta-functions and their properties that the rest of the book is principally concerned; chapters x., xi., xv.–xxi. are almost entirely devoted to them, and give, in fact, the most elaborate systematic treatment of the functions that has yet appeared

in English. The conciseness of the notation and the difficulty of the subject make these chapters very hard reading. Every one acquainted with the subject is aware that the multiple theta-functions sprang from a brilliant generalisation of Jacobi's functions $\Theta(u)$, $H(u)$, and that the *crux* of the whole matter is to establish, in a natural way, their connection with a set of algebraical functions. It is impossible to feel that this connection has been made in the really proper and natural way: the theta-functions drop out of the clouds, so to speak, and are joined up to the inversion problem in a more or less artificial and unsatisfactory manner. The most promising glimpse of a better method seems to be afforded by the "Prime Form" introduced by Schottky and Klein; and it is very satisfactory that due prominence is given to this function in chapter xiv. (on factorial functions) and elsewhere. It is very important to notice that this function admits of an independent definition, and that the three kinds of elementary Riemann functions may be directly and simply derived from it (see Arts. 233-5). Moreover there is a relation connecting any theta-function with a corresponding prime form (Arts. 237, 272-4). Thus the prime form has a strong claim to be considered fundamental; and it is not improbable that, by starting with it, the same kind of simplification may be attained as that which has been achieved in the theory of elliptic functions by the use of Weierstrass's sigma-function.

It would be unprofitable to attempt to give an abstract of the chapters on the theta-functions which Mr. Baker's book contains; enough to say that (besides the elementary properties) the relations among theta-products, the theory of transformation, and the theory of characteristics are all fully treated; account being taken not only of memoirs already classical, such as those of Rosenhain, Göpel, Hermite, and Weierstrass, but also of quite recent researches, such as those of Prym, Frobenius, Poincaré, and others. A certain amount of special attention is given to the hyper-elliptic case; this is justified by its comparative simplicity, and the large amount of literature connected with it.

Some parts of the book, especially the last two chapters (on complex multiplication of theta-functions, the theory of correspondences, and degenerate Abelian integrals), deal with problems of which the complete solution is still the object of research. This is a very welcome feature; for the unavoidable incompleteness of these parts is more than compensated by their stimulating quality. It is a pity that authors of mathematical treatises too often neglect the opportunity of carrying on a discussion to actual contact with current research, and pointing out the possible or probable direction of future development.

One characteristic of Mr. Baker's treatise seems to call for remark. On p. 93 the author says: "We desire to specify all the possibilities"; this sentence might have been adopted as a motto for the whole work. There is such a wealth of conscientious detail that we can imagine some readers failing to grasp the general argument, and becoming disheartened by the array of complicated formulæ with their plentiful adornment of suffixes. Of course, in order to treat the subject generally, a certain amount of complexity is unavoidable; there is, however, an alternative which can often be adopted, and is worth considering, namely, instead of introducing n symbols, say $x_1, x_2 \ldots x_m$, to use a limited number, say $x_1 x_2 x_3$ or $x\,y\,z$, and to give the demonstration in such a form that its generality can be inferred. It must be admitted that this course is not always practicable; the fact is that, in order to read modern analysis with comfort, a certain facility in handling sums and products in a condensed notation is almost indispensable, and should be acquired, if possible, at an early age, as in the analogous case of definite integrals.

The book contains a considerable number of illustrative examples, many of which are worked out in detail. These cannot but be of great help to the reader, by showing how the general theory is brought to bear upon particular cases. This is especially true in the actual construction of the Riemann integrals for a given plane curve.

Printers' errors appear to be very rare; on p. 138, line 14 from the bottom, "not greater than $Q - p$" should be "not less than $Q - p$"; and in the early part of Art. 176 there are several misprints, which, however, the reader can easily correct for himself.

There can be no doubt that this work will be highly appreciated by all who make a special study of Abelian functions; and we trust that, in the approbation of the limited circle to which he appeals, Mr. Baker will find a sufficient reward for the immense amount of labour which his task must have entailed. There is still room for a strictly introductory work, bringing out the salient features of the theory, and perhaps not disdaining "heuristic" methods of investigation. In spite of its limited scope and occasional diffuseness, there is a charm about C. Neumann's book which we miss in the more analytical treatises; something of this kind in English would probably do much to draw attention to this very fascinating field of research, and induce a select few to follow up the somewhat abstruse analysis which a more detailed study of the subject involves. Some reference to the historical evolution of the theory would not be out of place; indeed, we rather regret that the plan of Mr. Baker's treatise has tended to obscure this side of the matter. Cauchy is only mentioned once, and Puiseux not at all; yet the work of these two mathematicians was fundamental, and will always form a part of any systematic discussion of function-theory.

G. B. M.

THE CULTURE OF FRUIT.

The Principles of Fruit-Growing. By L. H. Bailey. Pp. xi + 508. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1897.)

FRUIT-GROWING in this country is one of the remedies proposed to counterbalance the effects of low prices for agricultural products. But fruit-growing is an art which cannot be learned without experience. It is no easy matter for a farmer to change his habits and his practices, even if the local conditions are favourable to the production of fruit; and the orchard of the farm is very generally the most neglected part of the whole establishment. Nevertheless, it is obvious that a great extension of fruit culture has taken place during

the last few years in the vicinity of London and other large towns. At the same time, market-gardening and the growth of grapes, tomatoes and cucumbers under glass have increased enormously, and the production of flowers for market has attained proportions undreamt of by our predecessors, and unthought of even a dozen years ago. Some of those who are among the most successful of these market-growers have been farmers, but farmers possessed of a power of adapting themselves to circumstances denied to many of their fellows. It is curious also, but none the less true, that many of the most successful market-growers—men who send in grapes to Covent Garden by the ton—were not originally either gardeners or farmers. They followed some other occupation, but, deeming it advisable, they altered their plans, took to market gardening, at first on a small scale, but gradually increasing till they became the proprietors of the vast establishments which are now to be seen in every direction round London and in the vicinity of large towns. These men are very shrewd men of business, and they are specialists confining themselves strictly to the cultivation, on an enormous scale, of one or two subjects only. They are not much troubled with principles—of course we are using the word in its scientific meaning!—but they have natural intelligence enough to accumulate experience rapidly, and wit enough to make the most of its application. The private gardeners of this country grow fruit which cannot be excelled, and barely rivalled in any country on the globe; but the cost of production, though by no means lost sight of, is not of such vital moment to them as it is to the market-grower, who has to make his living out of his business.

Putting on one side these two classes of fruit-growers, the market specialists and the gentlemen's gardeners, who both grow fruit well, there remains another class, the largest in numbers, the most widely scattered, and, we fear we must add, the most deficient, alike in principles and in practice. They are neglectful of the one, and unable to appreciate the value of the other. Yet this is the class that is suffering the most severely from agricultural depression, and the one for whose benefit fruit culture is prescribed. It is, however, pretty clear that little advance can be expected in the case of the present generation; it is to the younger generation now coming on that we must look for the results of technical education and technical training that are now more or less available. To these the work before us will be full of suggestions.

Over a large area of the United States fruit culture is carried on to an extent that is hardly realisable here, and it is "much more of a business" than it is with us. The author gives advice as to the locality and climatal conditions under which success may be confidently hoped for, deals with the methods of tillage, cultivation and manuring, and enumerates the most suitable varieties for particular purposes. The best modes of picking, grading, packing and sending to market are discussed. On the whole we find more of the practice than of the principles in this book; but it is so full of information and so replete with suggestion that we shall not cavil at its title, but recommend it to thoughtful cultivators who will be able to adapt it to their own uses—a process rendered easier by the table of contents and index with which the volume is provided.

OUR BOOK SHELF.

Masonry Dams from Inception to Completion, including numerous Formulæ, form of Specification and Tender, Pocket Diagram of Forces, &c. By C. F. Courtney, M.Inst.C.E. Pp. 103 + 33. Appendix. (London: Crosby Lockwood and Son, 1897.)

THIS book purports to be written for civil and mining engineers, but it is difficult to understand what purpose it is intended to serve. The author very correctly states in his preface that it is not an exhaustive treatise. The book is not sufficiently elementary for students, and contains practically nothing that a waterworks engineer of any experience would not be acquainted with. As regards its use by mining engineers, there is no special reference to the use of masonry dams for mining purposes, or examples given where masonry dams have been used for this purpose.

A scientific treatise may be valuable as a record of the views and experience of an author who has himself been largely concerned in designing and carrying out works of the nature dealt with. This book cannot come under this head, as from the description given on the title-page, it appears that until recently the author had only filled the office of assistant engineer to an Engineering Company and in the City Surveyor's office, Manchester. A treatise may also be of service where the author, having a practical knowledge of the subject with which he deals, collects together and puts into readable form theories, facts and descriptions of works scattered about in scientific proceedings and in the engineering journals. Such a work on the subject here dealt with would be of value, as giving examples of masonry dams which have been constructed in this and other countries, with illustrations of the sections and profiles adopted, and an account of the materials used in the construction. Such information is, however, conspicuous by its absence in the present volume, the only examples given being those of the Quaker Bridge and the Bouzey dams. Even the Vyrnwy dam for the Liverpool water supply, which during its construction excited a very large amount of attention and controversy, is only incidentally referred to.

The chapters on construction and calculations of stability contain some useful information, but nothing that is original or that has not been already as well told in books already in existence, and there are misprints in some of the figures which might prove very misleading if made use of.

It is at present the practice for those engaged in questions of water supply to use as units of measurement acres and square miles as areas, inches for rainfall, and gallons or cubic feet for quantities. The author, however, makes a free use of the metric system, and give a formula for what he terms "simplification of calculation," the units of which are expressed in centimetres and square and cubic metres. In other parts of the book the measurements and quantities are sometimes given in metric, and in other parts in English measures, and in one place the result of kilogrammes per cubic metre is given in pounds per cubic foot.

Biblioteca di Scienze Moderne, No. 1. *Africa: Antropologia della Stirpe Camitica.* By Giuseppe Sergi. Pp. 426. (Turin: Bocca, 1897.)

PROF. SERGI is an anthropologist whose views differ widely from those of other writers on the science, who, he complains, have down to the present left the subject in a state of chaos. In the present work he seeks to apply an improved method to the study of a particular section of mankind, viz. the Hamites of Africa. In subdividing the human race, Prof. Sergi depends on purely physical characters, discarding linguistic facts as untrustworthy as indications of affinity. He draws a broad distinction between what he terms the internal and external physical

characters, the former relating to the bony skeleton—particularly the skull—while the latter include such secondary characters as the colour of the skin, form of the hair, &c. He holds that the former are persistent, and that even in the case of a mixture of races they are not modified, but rather that the type of one or other of the parent stocks is maintained. The external characters are subject to modification from the influence of environment and other causes, so that the only trustworthy criterion of race is supplied by the internal.

Having in the body of the work examined in detail the various groups of Hamites in Africa, the author discusses in the final chapter the position occupied by them in the scheme of classification. Their internal characters show, he holds, a decided unity of type, which corresponds also with that found among the peoples of South Europe, already studied by him in a previous work. He therefore places the African Hamites with the South Europeans (and possibly the Semites) in one group, which he considers entitled to rank as a *species*, the word being understood in the sense of an animal group with fundamental characters not common to other groups. To it he applies the term "Eurafrican," but in a different sense to that in which it is employed by Brinton, Flower and Keane. Prof. Sergi's whole system thus rests on the supposed permanence of one set of characters, which is unlikely to be accepted as proved without further evidence, but the book is suggestive and valuable for the mass of facts which it brings together. It is abundantly illustrated with portraits of the different Hamitic types.

The A.B.C. of the X-Rays. By William H. Meadowcroft. Pp. 189. (London: Simpkin, Marshall, Hamilton, Kent, and Co., Ltd.)

"THE main object of this book," says the author, "is to present to the reader a practical explanation of apparatus and methods employed in producing and utilising the X-rays." To introduce the subject, there is a chapter in which various properties of light and electricity are described for the benefit of the general reader, to whom lenses and photography and the electric current are mysterious things. Following this is a brief mention of the apparatus used for exciting vacuum tubes, and then come chapters on induction, induction coils, contact breakers and condensers, and high frequency apparatus. There is a chapter on influence machines, and in it we have the usual descriptions of positive and negative electricity, with diagrams of their distribution upon an electrophorus in various stages; the attractions and repulsions of positive and negative are also traced in detail in the account of the Holtz machine. Eventually (Chapter ix.) we arrive at "The Crookes' tube," and are informed how Prof. Elihu Thomson, "as early as January 1896," found after an "exhaustive series of experiments," that the form of tube known as the focus tube was the best for Röntgen ray work. We also learn that Mr. Shallenberger and Mr. Scribner used this standard form of tube early in 1896, but nothing is said of the prior use of the focus tube by Mr. Herbert Jackson in this country. Mr. Edison is given "the credit of making the practical device known as the Fluoroscope," to the description of which a chapter is devoted. Probably Mr. Edison would not himself claim much credit for the very obvious extension of Prof. Röntgen's original observations involved in the construction of the fluoroscope. Moreover, the instrument is practically the same as the cryptoscope described by Prof. Salvioni at the beginning of February 1896.

The remaining short chapters of the book deal with the sources of excitation of vacuum tubes, manipulation of apparatus, practical suggestions, and photographic plates and developers.

Though published in London, the book is evidently an American production.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Corona Spectrum.

IN your article on the approaching solar eclipse (page 393, paragraph 2), reference is made to the apparent absence of the corona line, 1474 K, from the chromosphere and prominences. I would like to point out that occasionally this line is clearly seen reversed in metallic prominences; and that the form of the prominence, generally a very small one, can be made out with the widened slit as in the other chromosphere lines. Such an instance is recorded by Fenyi, who has published a drawing of the prominence as seen in the lines 6677, C, and 1474 K; the height as measured in the last-named line being 33" ("Astronomy and Astro-physics," xi. 432, 1892).

Prominences of 1474 light very rarely reach this altitude above the limb, but the writer has several times noted small metallic prominences reversing the corona line; and during 1895 (a year of great relative frequency) the line was recorded "bright" in the chromosphere twelve times in 134 days of observation; always in the spot latitudes, and at the very base of the chromosphere, never in the coronal region above. Although not therefore truly coronal in this sense, these reversals may possibly have formed the bases of the bright coronal streamers which emanate from the spot zones during a maximum spot period.

With regard to the H and K radiations, the evidence now seems conclusive that these lines were not present in the corona of 1893, and it may be assumed that the lines photographed by Deslandres during this eclipse, with slit spectroscopes, were due to atmospheric diffusion of the brilliant chromosphere radiations, as suggested by the writer at the time the results were published (NATURE, xlviii. 268, 1893). The relative displacements measured by Deslandres on opposite sides of the solar equator would seem, therefore, merely to prove a rotation of the *chromosphere*, not of the corona.

J. EVERSHED.

August 29.

The late Earthquake in India.

THE following extract from a letter just received from my son, who is at present in Assam, investigating the effects of the recent earthquake, may be of interest. In communicating it to NATURE, he wishes it to be understood that his remarks on the cause of the event are but tentative and subject to revision on further information which is being collected by his colleagues on the Survey.

J. D. LA TOUCHE.

Stokesay, Craven Arms, August 18.

"*Shillong, July* 23.

"You will, no doubt, have been greatly interested in hearing of this earthquake, though from the accounts that have been telegraphed home you will not have got much information about it. All this talk of railways disappearing, and whole villages being swallowed up, is very far beyond the facts; though, indeed, things are bad enough. The whole of the damage was done by the first great shock, which lasted in these parts about two minutes. After that there were a number of other shocks, estimated at between 300 and 400, in the first twenty-four hours, but none of them nearly so violent as the first. The ground certainly was fissured in many places, and a large quantity of sand and mud was thrown out; but this is a secondary effect of the earthquake, and happens only in loose soil or in the alluvium of the valleys. Such fissures occur near river-banks and such-like places, and are due to the forward movement of the soil where no mass exists in front of the wave to carry on its motion, somewhat analogous to the forward movement of waves of water when they reach the shore. The fissures are quite superficial, and the sand and water is merely jerked out of them, of course during the actual progress of the shock only. The statement that sand and mud are constantly spurted out, is quite misleading. These fissures were studied by Dr. Oldham in the Cachar earthquake of 1869, when he found out the cause of them. The loss of life has been very small: only one child at Dhubri and a few at Goalpara, where one of these fissures opened under one side of the bazaar, and filled the street and houses with sand. The river there only rose eight feet, and did not reach the bazaar itself. A

small portion of the crops has been destroyed by sand and mud, but nothing like the amount that was supposed at first. Here every house and structure that was built of stone was simply shaken to pieces; but the buildings were never intended to stand earthquakes, and when one sees the kind of structures they are, great shapeless lumps of stone laid in very inferior mortar, one is not surprised that they all came down, though it is doubtful whether the best of masonry would have stood the shock. In the cemetery huge slabs of granite or marble have been jerked several inches out of their places. It has been most interesting work investigating the results of the shock. I have not yet heard what opinion my colleagues, who have gone out in various directions to make observations, have formed about the cause of the shocks; but my own opinion is that they are due to movement along a line of fault running along the southern side of the Khasia and Garo Hills, from near Cachar on the east to and beyond the Bramahputra. If you look at the map of Assam you will see that the southern boundary of these hills is a very straight line. The rocks are bent down suddenly along this line in a uniclinal curve, and to the south of it the plains of Sylhet and Lower Bengal are certainly a region of subsidence. If I should prove to be right, it will be a most interesting case of earth-movement on a large scale. I believe also that the 'Barisal guns,' which have been a puzzle for so many years, are connected with the same movement, and are caused by slight slips, not sufficient to cause actual shocks of earthquake. The sounds one hears here, sometimes accompanied or followed by a shock, but sometimes also without any shock, are exceedingly like the 'guns.'

"At the beginning of the week I put up here a roughly constructed seismograph for observing the shocks, which still continue, though they are gradually getting less violent and less frequent than at first. The instrument is in principle, I believe, due to Prof. Ewing, of Tokio, and gives a trace of the horizontal movement of a point on the surface of the earth on a piece of smoked glass. From this it is easy to take prints on a piece of sensitised paper, and I send you some of the results [one of the prints is here reproduced] I have already obtained. The trace is magnified 6·7 times by the instrument, so that one can form an idea from it of how exceedingly minute the actual movement of the surface is, and yet the two taken in the morning of the 19th were fairly severe shocks. The first, at 1.39 a.m., was a very sudden bump, and was soon over; but the other, at 6.50 a.m., lasted some fifteen to twenty seconds. This instrument cost altogether about 6*d*. to put up; I am making another rather more carefully, which will be looked after by the Public Works Engineer here when I leave.

"The house I used to live in is perfectly flat on the ground. It is wonderful that so few people were killed; but the first shock came at a time of day when most people were out of doors, and only two Europeans were killed and about ten natives, who were all in the Government Press building, the only house of more than one story in the place. If it had happened at night, or at the same time next day, when many of the people would have been at church, there would have been great loss of life. I am going on from here to Cherrapungi, where the damage has been very great, chiefly caused by landslips, and then back to Calcutta through Sylhet."

The Centipede-Whale.

I AM very much desirous of being informed by you, or some of your readers, what animal is meant by "Scolopendra Cetacea," which, according to Johnston, has only been described by Ælian: "Scolopendrae vim et naturam, . . . quoddam etiam maximame cètos marinum eam esse audivi, quam de mari tempestatibus in litus expulsam nemo foret tam audax, quin aspicere horreret. Ii verò qui res maritimas percallent, eas inquiunt toto capite spectari eminentes è mari: et narium pilos magna excelsitate apparere, et ejus caudam similiter atque locustae latam perspici: reliquum etiam corpus aliquando in superficie aequoris spectari, idque conferri posse cum triremi instae magnitudinis, atque permultis pedibus utrinque ordine sitis, tanquam ex scalmis appensis, natare. Addunt harum rerum periti ac fide digni, ipsos etiam fluctus ea natante leviter subsonare." ("De Natura Animalium," lib. xiii. cap. 23.) In Gesner's "Historia Animalium," lib. iv., Francfort, 1604, p. 838, a figure is given of this animal said to have been seen in India.

That the Japanese of old had some notion of such an animal is well shown in Kaibara's "Yamato Honzô" (1708, tom. xiii. f. 41, b.), where it is said: "The *Mukade-Kujira* [= Centipede-Whale] is as large as a whale, and has five fins on the back and a two-cleft tail. Its legs number twelve, six being on each side; its flesh is coloured red and very venomous, man being killed when he eats it."

Here I may add that Olaus Magnus's "Cetus Barbatus," which is assimilated with the "Scolopendra Cetacea" in the book of Gesner (*ut supr.*, and figured on p. 207), appears to be but an exaggerated portrait of some huge Cephalopod; and also that I was lately told by Captain Miura, of the *Fuji*, of his having experienced a serious illness in consequence of eating flesh of a gigantic cuttlefish in the Pacific Ocean.

KUMAGUSU MINAKATA.

15 Blithfield Street, Kensington, W., August 30.

THE APPROACHING TOTAL ECLIPSE OF THE SUN.[1]

VI.

IN the third article under the above heading, when referring to the suggested programme for the observations of the next eclipse, I stated briefly the divergent views held with regard to the true *locus* of origin of the absorption which produces the Fraunhofer lines. It is, I think, worth while to return to this subject in order that the results obtained from the double series of photographs obtained during the eclipse of 1893 may be indicated. I pointed out that in the photographs in question the radiation spectrum was most distinctly *not* identical with the Fraunhofer spectrum; the most important point being that some of the strongest bright lines do not appear among the dark ones in the solar spectrum, while some of the strongest dark lines are not seen bright in the spectrum of the stratum of vapours in immediate contact with the photosphere. The region covered by the diagram, given in my paper in the *Phil. Trans.*, lies between wave-lengths 4100 and 4300, but similar results follow when other regions are included in the inquiry.

These positive conclusions are not weakened by the consideration that the resolving power of the prismatic cameras employed in 1893 is not sufficiently great to show all the lines of the Fraunhofer spectrum, which is used as a term of comparison; in fact, working under exactly the same conditions as during the eclipse, the instrument employed in Africa only shows 104 lines in the spectra of stars resembling the sun, in the region *h* to H, in place of 940 given in Rowland's tables of lines in the solar spectrum. We, therefore, get a better term of comparison if we employ the spectrum of some star such as Arcturus, which closely resembles the sun. Such a comparison is shown in Fig. 24; out of 104 lines which the instrument is capable of depicting in the region *h* to H, only 40 are shown in the spectrum of the base of the sun's atmosphere. This comparison amply confirms the conclusion that the lines reversed at the beginning or end of totality, though fairly numerous, do not correspond in intensity, though some of them correspond in position with the dark lines of the solar spectrum, and consequently that the so-called "reversing layer" close to the photosphere is incompetent to produce, by its absorption, the Fraunhofer lines. Further, as previously pointed out, while the chromosphere fails to show most of the lines

[1] Continued from p. 395.

which are present in the Fraunhofer spectrum, it shows many bright lines which are not represented among the dark ones. This again indicates that the chromosphere is not the origin of the Fraunhofer spectrum

It is all the more important to call attention to the advantage we now possess in being able to directly compare photographs of the chromosphere obtained during eclipses with others of the spectra of stars resembling the sun, since, as I have already stated, if all goes well next year, double the dispersion utilised in 1893 will be employed. This is certain not only to enable us to obtain more accurate wave-lengths, but the number of Arcturus- and chromospheric-lines *obtained by the same instrument* will be very greatly increased.

In the meantime we must take the above as one of the most positive results secured in the eclipse of 1893.

The Spectra of Prominences at Different Heights.

There is another matter of almost equal importance in which the increased dispersion designed to be employed in 1898 will in all probability prove of the utmost value. I refer to the differences in the spectra as we work outwards from the photosphere.

The questions touching the spectra of prominences at different heights, which the prismatic camera enables us to study with minuteness, must really lead in time to a much better knowledge of the loci of absorption in the solar atmosphere. If we consider a prominence on that part of the sun's limb where the second contact takes place, the first photograph taken during totality will show the spectrum of the whole prominence, and succeeding photographs will give the spectrum of the same prominence with the lower parts gradually cut off by the moon's edge. In the case of a prominence at the opposite limb, similar sections will be represented in successive photographs, and the last photograph taken during totality will show the spectrum of the greatest part of the prominence.

Some of the 1893 prominences (Nos 3 and 19) have been investigated in this way, and particulars of their spectra at various heights recorded. The height above the photosphere, reckoned in seconds of arc and in miles, at which each spectrum is given, has been calculated. The relative intensities of the lines at different heights have been tabulated. In this way it has been found that some of the lines remain of the same relative intensity throughout all parts of the same prominence; others again dim rapidly in passing towards the upper parts, while some, but not so many, brighten.

The prominences are also seen to behave differently in respect to some of the lines; thus the line at λ 3856·5 disappears before a height of 2000 miles is reached in prominence No. 3, but remains visible at a height of over 4000 miles in prominence No. 19. Lines also occur in one prominence which do not appear in the other, *e.g.* λ 4313·2. Other differences are also revealed, but it may be remarked that too much stress should not be laid on the presence or absence of the very faintest lines in some of the photographs, as variations may be partially attributed to differences in the quality of the photographs, and also to the time of exposure and degree of development.

The changes in the spectrum of a prominence in passing from the top towards the base are illustrated in Fig. 25. Spectra *a*, *b*, and *c* represent the spectrum of Pro-

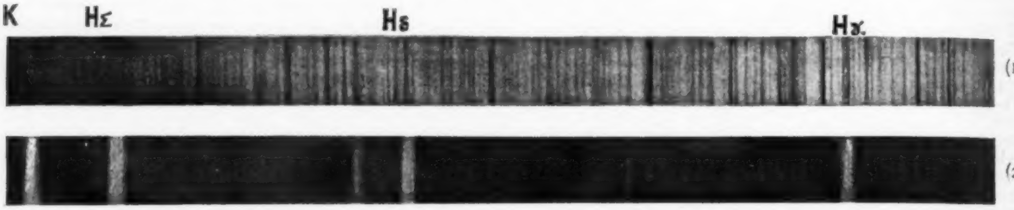

FIG. 24.—The spectrum of Arcturus (1) compared with that of the base of the chromosphere photographed during the eclipse of 1893 (2).

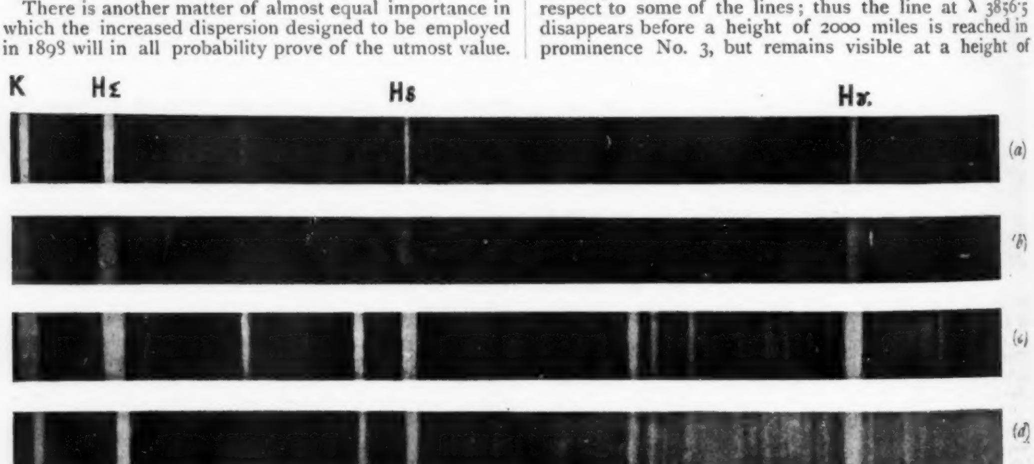

FIG. 25.—The spectra, *a*, *b*, *c*, of Prominence No. 3, photographed during the eclipse of 1893, compared with the spectrum of the base of chromosphere (*d*)
(*a*) 22″–26″ above photosphere.
(*b*) 7″–9″ " "
(*c*) 3″–4″ " "

minence No. 3 as it appears in the African Photographs Nos. 11, 9, and 7 respectively, the first giving the spectrum of the upper part only, while the last shows the spectrum nearer the base. Accepting the time of commencement of totality in Africa as 2h. 23m. 48s. by the deck watch, it has been calculated that Spectrum 1 represents a part of the prominence 22″–26″ (9950 to 11,600 miles) above the photosphere; Spectrum 2, 6″·7–8″·5 (3000 to 3800 miles); and Spectrum 3, 3″·7 (1660 miles) above the photosphere. Strip *d* is the spectrum of the base of the chromosphere as represented by the cusp in the African Photograph No. 22.

These enlarged spectra have been obtained by covering copies of the original negatives with tinfoil, leaving only narrow strips showing the prominence spectra, and giving them the necessary width by moving the photograph in a direction at right angles to the length of the spectrum.[1]

The want of exact coincidence of lines common to different horizons in the copies of the photographs which I have given is due to the difficulty of obtaining enlargements on exactly the same scale. The difference in thickness of the same line in different photographs of a prominence is due to the varying widths of the corresponding images of the prominence formed by the prismatic camera at different stages of the eclipse.

In order that the changes of intensity of the various lines may be separated from the effects due to varying exposures, the individual observations are arranged in groups according to the time of exposure of the photographs.

In contrasting the spectrum of the prominences with the spectrum of the cusp, it should be borne in mind that the cusp in the African photograph specially examined (No. 22), does not represent the base of the chromosphere immediately beneath either of the metallic prominences. Still the cusp was not far from a prominence (No. 19), and it is fair to consider the base of the chromosphere homogeneous. If so, the prominences cannot be fed from the base of the chromosphere, since they contain different vapours.

The Spectrum of the Chromosphere at Different Heights.

But we are not limited in these investigations to the study of the prominences; we can obtain similar information from the chromosphere itself.

The spectrum of the chromosphere itself at different heights can also be partially investigated in the eclipse photographs. A considerable arc of chromosphere was photographed in one of the African negatives (No. 21). The photograph was taken about ten seconds before the end of totality, so that the lower reaches of the solar atmosphere within 1660 miles of the photosphere were hidden. The bright arcs accordingly represent the spectrum of the chromosphere above that height. None of the photographs give us any information as to the spectrum lower down until we come to the part very near to the base which is shown at the cusp in another photograph (22). Most of the lines become relatively brighter as the base of the chromosphere is approached, but some become dimmer.

The Evidence as to the Existence of Layers in the 1893 *Photographs.*

The most direct evidence which the eclipse photographs give as to the separation of the solar atmospheric vapours into layers is that afforded by the increased relative brightness of some of the lines in passing to higher levels.

We have seen that a careful and impartial tabulation of intensities has shown that both in the prominences and in the chromosphere some vapours do seem to be brighter as they increase their distance from the photosphere.

[1] *Phil Trans.*, 1893, vol. clxxxiv. A. p. 684.

As we have to deal with the projection of a sphere and not with a section of the sun's atmosphere, the spectrum arcs would brighten in passing outwards from the photosphere in consequence of the increased thickness of vapour presented to us, even if the radiation per unit volume remained constant. The spectroscopic differences studied and carefully recorded show, however, numerous inversions even in the behaviour of the same line in different prominences, so that the increased brightness observed cannot always be due to this cause alone.

Some of the lines are brightest at the base of the chromosphere, while others are brighter at greater elevations. As already explained, some of the lines which are brightest above the photosphere are probably produced by vapours existing in layers concentric with, but above and detached from the photosphere. Those lines which become dimmer in passing outwards must owe their origin to vapours resting on the photosphere.

It will be obvious to everybody that the more the idea of the absorption which gives rise to the Fraunhofer lines taking place in one thin layer is disproved, the more certain it must be that it represents the integrated effect of several layers. Hence this special examination of the 1893 photographs, to which I am now directing attention, to see if there are any indications as to the localisation of the absorbing vapours which are not represented in the base of the chromosphere.

It will be noted that the evidence is distinctly in favour of such localisation *above* the chromosphere.

But the matter is so important that it must not be allowed to rest here, while photographs with higher dispersion are possible. Hence, then, the 1898 results must be carefully studied from this point of view.

The Chemical Constitution of the Sun's Atmosphere.

The results obtained with regard to the chemistry of the sun will, of course, depend upon the results of the accurate measurement of the arcs, both long and short, obtained in the prismatic cameras; and of the lines—true images of the slit—in slit spectroscopes; these measurements have for their object the determination of the wave-lengths of the radiations, so that they can be compared with the wave-lengths of terrestrial substances observed in the laboratory.

The dispersion employed in 1893 was only moderate as compared with that now used in laboratory work, though it was far greater than any employed in eclipse observations before. The doubled dispersion proposed for 1898 will necessitate additional precaution against error, and in return it may land us in new discoveries. To show that this remark is justified, I will first refer to the method employed in the determination of wave-lengths in the case of the photographs of the 1893 and 1896 eclipses.

The wave-lengths are expressed on Rowland's scale. In the region less refrangible than K, they have been determined from the African photographs, by comparison with the spectrum of Arcturus and other stars photographed with the same instrument, the wave-lengths of the lines in which were determined by reference to Rowland's photographic map. The spectrum of Arcturus is almost identical with that of the sun, so that the comparison lines were sufficiently numerous for the purpose. Stars like Bellatrix were employed as an additional check in the case of bright lines not coincident with prominent Fraunhofer lines.

Micrometric measurements of the lines were also made and reduced to wave-lengths in the usual way, by means of a curve; these furnished a check on the general accuracy. In the case of the Brazilian negatives wave-lengths were determined by means of micrometric measures and a curve, and checked by direct comparisons with a solar spectrum, photographed with the same spectroscope while it was temporarily provided with a slit and

collimator. For the reduction of the ultra-violet, in both series of photographs the wave-lengths of the hydrogen lines have been assumed as far as H_ϕ from those given by Hale,[1] with the exception of H_ν, which falls sufficiently near the calculated wave-length to be accepted as a hydrogen line.

With these as datum lines, wave-length curves were constructed, and the wave-lengths of the other lines found by interpolation.

The wave-lengths of the radiations more refrangible than H_ζ were determined from extrapolation curves, so that the degree of accuracy is necessarily less than in the case of the remaining lines.

The scale of intensities adopted is such that 10 represents the brightest lines and 1 the faintest. This facilitates comparisons with Young's well-known list of chromospheric lines, in which 100 represents the maximum frequency and brightness. The intensities have been estimated by taking the strongest line in each negative as 10, irrespective of length of exposure.

This much being premised, let us next consider the thing that is actually measured. If we study the actual photographs, or such reproductions as have been given in Figs. 17 and 18, it will be clear in a moment that the arcs are of different widths because some of the vapours and gases extend further above the photosphere, and therefore above the dark moon which covers it during an eclipse, than others. Obviously, then, we must not take the *centre of the arc*. It is also obvious that we must not take that edge further from the dark moon. If we did either of these things, the positions of the lines thus recorded would depend not only on the wave-length of the radiations of the vapours and gases which produced them, but also upon the thickness of the vapours.

If, however, we take the edge of the arc at the moon's edge, in every case we shall have a series of numbers involving wave-length only, *except under two conditions*, and this is a very important exception.

The first condition which may vitiate the determination of wave-length in this way is that some of the vapours or gases producing certain lines may be in movement sufficiently rapid along the line of sight to change the wave-lengths of the lines according to a well-known law. Suppose, for instance, we have a stream of iron vapour moving at the rate of fifty miles a second towards the eye through a mass of hydrogen at rest; the lines of the iron spectrum will be shifted towards the violet part of the spectrum, while those of hydrogen will be in their normal position. The higher the dispersion employed, the more carefully must such matters as this be studied. This cause, in fact, will in the case of very violent motion change even the forms of the prominences.

The forms of monochromatic images of the prominences being produced in part by the movement in the line of sight of the vapours which give rise to them, regions in which the vapours are approaching the earth will be displaced to the more refrangible side of their true positions with respect to the sun's limb, and in the case of receding vapours there would be displacements towards the less refrangible end. Such distortions can be determined, if they exist, by comparing the monochromatic images with those photographed at the same time with the coronagraph. For this purpose, in dealing with the eclipse of 1893 a photograph of the eclipsed sun was enlarged to exactly the same size as the K ring shown in Fig. 9, and the comparison could be made very exactly by fitting a negative of one to a positive of the other. No differences of form, however, could be detected, so that the velocities in the line of sight must have been comparatively small. Movements across the line of sight will not affect the forms of the monochromatic images of the prominences.

[1] "Astronomy and Astrophysics," 1892, pp. 50, 602, 618.

This is a true physical origin of the change of wave-length which may be detected in eclipse photographs; but there is a second, as I have hinted. This, although only an apparent change, has to be reckoned with, since, on the one hand, it may be very misleading, while, on the other, if properly dealt with, it may furnish us with new knowledge.

I have already pointed out that in the determination of the wave-length of the arcs in the prismatic camera photographs the edge of the line nearest to the dark moon must be measured, rather than the other edge or the middle of the arc. But this assumes that all the arcs really rest on the dark moon. *It is possible, however, that some of them do not extend down to it—that they represent real upper layers*, and in this case the wave-length obtained by a reference to the dark moon will not be the true one, and, by some means or another, it will have to be corrected. This, though a difficult problem, does not seem an impossible one.

Eclipse Work in relation to the Dissociation Hypothesis.

In the course of the spectroscopic solar investigations which have been going on since 1868, I have pointed out over and over again that the phenomena observed could be more easily explained on the hypothesis that the chemical elements with which we are familiar here were broken up by the great heat of the sun into simpler forms, than in the ordinary one that the "elements" as we deal with them in laboratories are incapable of simplification, that is that they are indestructible.

The recent work on the enhanced lines of several of the metallic elements, really enables us to predict what we shall obtain in the Indian eclipse if the dissociation hypothesis be true.

With regard especially to the bearing of the 1893 work on this view, I may state that it is entirely in its favour. The preliminary discussion of individual substances has further abundantly shown that although some of the lines belonging to any particular metal may appear as dark lines in the solar spectrum on account of absorption by the chromosphere, other lines of the same substance are only represented among the dark lines because of absorption taking place elsewhere. This again is an indication of the stratification of the sun's absorbing atmosphere, which, if it exists, must furnish a very strong argument in favour of the dissociation of metallic vapours at solar temperatures. In fact, the eclipse phenomena have been found to be as bizarre, in relation to the non-dissociation hypothesis, as those which I have already discussed in relation to observations of sun-spots, chromosphere, and prominences, made on the uneclipsed sun.

The long-continued Italian observations of the quiet solar atmosphere and the Kensington observations of sun-spots have already been especially mentioned. Not only is there no correspondence in intensity, but the variation in the sun-spot spectrum from maximum to minimum is enormous, while the Fraunhofer lines remain constant.

The view I expressed in 1879,[1] and to which I adhere, is therefore strengthened by the eclipse work. I then wrote: "The discrepancy which I pointed out, six years ago, between the solar and terrestrial spectra of calcium is not an exceptional, but truly a typical, case. Variations of the same kind stare us in the face when the minute anatomy of the spectrum of almost every one of the so-called elements is studied. If, therefore, the arguments for the existence of our terrestrial elements in extra-terrestrial bodies, including the sun, is to depend upon the perfect matching of the wave-lengths and intensities of the metallic and Fraunhofer lines, then we are driven to the conclusion that the elements with which we are acquainted here do not exist in the sun."

[1] *Roy. Soc. Proc.*, 1879, vol. xxviii. p. 13.

Conclusion.

In the course of this series of articles, I have referred to the many points on which light was thrown by the observations made in 1893.

It is quite obvious that the aim of those who observe in India next year with the view of advancing the more important problems of physics and chemistry presented to us by the eclipsed sun, should work along the new lines with a view of testing the soundness of the conclusions so far arrived at, and of obtaining new knowledge. I cannot, I think, more fitly close this article than by giving a very brief summary of the conclusions arrived at in the observations of 1893, so that my readers can gather the drift of much of the work that will be undertaken in 1898.

(1) With the prismatic camera photographs may be obtained with short exposures, so that the phenomena can be recorded at short intervals during the eclipse.

(2) The most intense images of the prominences are produced by the H and K radiations of calcium. Those depicted by the rays of hydrogen and helium are less intense and do not reach to so great a height.

(3) The forms of the prominences photographed in monochromatic light (H and K) during the eclipse of 1893, do not differ sensibly from those photographed at the same time with the coronagraph.

(4) The undoubted spectrum of the corona, in 1893, consisted of seven rings besides that due to 1474 K.

The evidence that these belong to the corona is absolutely conclusive. It is probable that they are only represented by feeble lines in the Fraunhofer spectrum, if present at all.

(5) All the coronal rings recorded were most intense in the brightest coronal regions near the sun's equator as depicted by the coronagraph.

(6) The strongest coronal line, 1474 K, is not represented in the spectrum of the chromosphere and prominences, while H and K do not appear in the spectrum of the corona, although they are the most intense radiations in the prominences.

(7) A comparison of the results with those obtained in previous eclipses confirms the idea that 1474 K is brighter at the maximum than at the minimum sun-spot period.

(8) Hydrogen rings were not photographed in the coronal spectrum of 1893.

(9) D_3 was absent from the coronal spectrum of 1893, and reasons are given which suggest that its recorded appearance in 1882 was simply a photographic effect due to the unequal sensitiveness of the isochromatic plate employed.

(10) There is distinct evidence of periodic changes of the continuous spectrum of the corona.

(11) Many lines hitherto unrecorded in the chromosphere and prominences were photographed by the prismatic cameras.

(12) The preliminary investigation of the chemical origins of the chromosphere and prominence lines enables us to state generally that the chief lines are due to calcium, hydrogen, helium, strontium, iron, magnesium, manganese, barium, chromium, and aluminium. None of the lines appears to be due to nickel, cobalt, cadmium, tin, zinc, silicon, or carbon.

(13) The spectra of the chromosphere and prominences become more complex as the photosphere is approached.

(14) In passing from the chromosphere to the prominences some lines become relatively brighter, but others dimmer. The same lines sometimes behave differently in this respect in different prominences.

(15) The prominences must be fed from the outer parts of the solar atmosphere, since their spectra show lines which are absent from the spectrum of the chromosphere.

(16) The absence of the Fraunhofer lines from the integrated spectra of the solar surroundings and uneclipsed photosphere shortly after totality need not necessarily imply the existence of a reversing layer.

(17) The spectrum of the base of the sun's atmosphere, as recorded by the prismatic camera, contains only a small number of lines as compared with the Fraunhofer spectrum. Some of the strongest bright lines in the spectrum of the chromosphere are not represented by dark lines in the Fraunhofer spectrum, and some of the most intense Fraunhofer lines were not seen bright in the spectrum of the chromosphere. The so-called "reversing layer" is, therefore, incompetent to produce the Fraunhofer spectrum by its absorption.

(18) Some of the Fraunhofer lines are produced by absorption taking place in the chromosphere, while others are produced by absorption at higher levels.

(19) The eclipse work strengthens the view that chemical substances are dissociated at solar temperatures.

NORMAN LOCKYER.

VICTOR MEYER.

VICTOR MEYER was born on September 8, 1848, and died on August 8, 1897. He studied chemistry at Heidelberg, under Bunsen, and at Berlin, under Baeyer. His first official appointment was at Stuttgart, whence he was called, in 1872, to the chair of Chemistry at the Zürich Polytechnic. In 1885 he went to Göttingen, and in 1889, on the retirement of Bunsen, he was appointed Professor of Chemistry at Heidelberg. The later years of his life were clouded by ill-health. His almost abnormal mental activity allowed him no rest, and he suffered greatly from insomnia. To the effects of this malady on a highly sensitive nervous organisation must be ascribed his tragic death in the midst of a career which, brilliant though it was, gave promise of still greater things in the future.

As an investigator Victor Meyer undoubtedly stands in the very front rank. In these days of specialisation it is given to but few men to possess a complete mastery over more than one department of a science. Meyer was equally at home when dealing with the problems of physical chemistry and when working out the chemistry of a group of organic compounds.

His first important investigation was that on the nitro-paraffins. In 1872 he discovered nitro-ethane, and, following this up with characteristic energy, had soon studied several of its homologues, as well as secondary and tertiary nitro-paraffins. By the action of nitrous acid on these substances he obtained nitrolic acids and pseudo-nitrols, and, by his study of these substances, cleared up the constitution of iso-nitroso and nitroso compounds. In 1882 he made the important discovery that iso-nitroso compounds are formed by the action of hydroxylamine on aldehydes and ketones. The generality of this reaction has been of considerable importance in the determination of the constitution of organic compounds, affording a sure indication of the presence of a carbonyl group.

Meyer's discovery of the oximes may be regarded as the foundation of our knowledge of the stereochemistry of nitrogen, for in 1888, working with his pupil Auwers, he showed that the two isomeric benzil dioximes then known were structurally identical. It is of interest that the molecular weights of these bodies were shown to be identical by means of the, then little known, cryoscopic method. To the further development of the stereochemistry of nitrogen, Meyer and his pupils contributed not a little.

The discovery of thiophene in 1882 by Victor Meyer was the result of a lecture experiment which failed. Benzene prepared from benzoic acid was shaken with strong sulphuric acid and isatin, and failed to give the

usual blue colouration. Further investigation revealed the fact that the blue colouration is due to an impurity in ordinary coal-tar benzene, viz. thiophene. The discovery of this remarkable substance was of great importance, giving a deeper insight into the nature of aromatic substances. Six years after the discovery of thiophene, he was able to publish a monograph "Die Thiophengruppe," containing a masterly account of thiophene and its derivatives, practically the whole of the work having been carried out in his own laboratory.

Another extremely interesting group of compounds, our knowledge of which is due to V. Meyer and his pupils, is that derived from the hypothetical iodonium hydroxide, $IH_2.OH$. In these substances the iodine plays a part analogous to that of nitrogen or sulphur in the ammonium and sulphonium compounds. The curious and striking resemblance of the corresponding diphenyl iodonium and thallium salts is very suggestive.

Many of his investigations related to the connection between the constitution of a substance and the relative ease with which it entered into a given reaction. As examples may be mentioned his work on the influence of certain groups on the acid properties of substances containing them, and that on the relative ease of etherification of substituted benzoic acids, and on the formation of oximes or hydrazones of aromatic ketones.

Victor Meyer's best-known work is certainly that on vapour-density. A description of his air-displacement method of determining vapour-density is to be found in almost every text-book of chemistry, and a specimen of his apparatus in almost every laboratory in the world. The method was devised in 1878, and since then hardly a year has elapsed in which he has not described some improvement of the apparatus, rendering it capable of more extended usefulness or some results, frequently of the highest interest, obtained by means of it. It is not easy to realise how little we would know of the molecular condition of vapours, especially at high temperatures, if Meyer's work in this direction were swept away. In a fascinating paper published in 1890, entitled "Chemische Probleme der Gegenwart," he gives rein to his scientific imagination, and discusses what might occur if it were possible to carry out vapour-density determinations at temperatures as much above the highest now reached as the latter are above the ordinary temperature.

In recent years he paid much attention to the study of chemical change in gaseous systems. The investigation of the reaction between iodine and hydrogen is particularly noteworthy as affording one of the very few examples known of a normal reaction between gases.

As a lecturer, Victor Meyer was equally admirable. He had a wonderful power of rapidly presenting a subject clearly to his students, and, at the same time, of impressing fundamental conceptions on their minds. He was never dogmatic; if there were two views current on any subject he carefully explained both of them, leaving his hearers to form their own opinions. The bearing of chemistry on practical matters was not forgotten; for example, when dealing with sugar he sketched the development of the German beet-sugar industry, and gave an account of the legislation connected with sugar bounties and its economic consequences. The experimental illustration of his lectures was extremely complete and carefully prepared. This was not only the case with the lectures on inorganic, but also with those on organic chemistry, the number of substances prepared in the latter being quite astonishing. To make this possible in cases where, for example, a prolonged heating was necessary, the beginning of the reaction was shown in one experiment, the end of it in another, which had been started before the lecture.

The "Lehrbuch der Organischen Chemie," by Victor Meyer and Paul Jacobson, the first part of which appeared in 1891, is written with that freshness which is hardly possible without an intimate personal acquaintance with the subject. It is especially valuable in these latter days, when the writing of text-books by men who take a foremost part in investigation is not so common as in the time when Berzelius, Liebig, Gerhard and Kekulé wrote their classical works.

NOTES.

THE French Academy has just accepted the administration of M. Pierre Lasserre's legacy, now amounting to 576,450 francs. In accordance with the terms of the bequest, the capital sum will be divided in three parts, the interests upon which will be awarded to the author of the best literary work, for an important scientific discovery, and to the composer of the best musical work. The respective awards will be made by the French Academy, the Academy of Sciences, and the Academy of Fine Arts.

THE Council of the Society of Arts have appointed the following Committee to investigate the causes of the deterioration of paper: Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., Chairman of the Council; Sir William Anderson, K.C.B., F.R.S., Mr. Michael Carteighe, Mr. C. F. Cross, Sir John Evans, K.C.B., F.R.S., Dr. Richard Garnett, C.B., Dr. Hugo Müller, F.R.S., Dr. W. J. Russell, F.R.S., Mr. W. L. Thomas, Prof. J. M. Thomson, F.R.S., Mr. Henry R. Tedder, Dr. Quirin Wirtz, Sir Henry Trueman Wood, Secretary. In the course of a circular letter which has been sent to those who are interested in the preservation of paper, it is pointed out that many books of an important character are now printed upon paper of a very perishable nature, so that there is considerable risk of the deterioration and even destruction of such books within a limited space of time. This is believed to be especially true of books which are in constant use for purposes of reference, and are therefore liable to much handling. Although a great deal of investigation has been made into the subject in Germany, the matter appears to have attracted but little attention in this country. The Council of the Society of Arts therefore readily acceded to a proposal made to them, and appointed a Committee to inquire into and report upon the whole subject.

AT Crevalcore, a small town situated on the outskirts of Bologna, there was to be unveiled yesterday, September 8, a bronze monument erected in honour of Marcello Malpighi, the celebrated Italian anatomist, botanist, and microscopist, the contemporary, amongst others, of Hooke, Grew, and Oldenburg; names famous in the early annals of our Royal Society. Malpighi's relations, indeed, with that Society were close and cordial throughout. His interesting correspondence with Henry Oldenburg, its first Secretary, and with men equally concerned in the "Improvement of Natural Knowledge," is carefully preserved in the Society's archives. Not only this, his autobiography, and many most important contributions to the anatomy of plants, and discoveries in physiology were published in London under the auspices of the Royal Society, notably "Anatome Plantarum" (1672), and "De Structura Glandularum conglobatarum" (1689), as well as his treatise on the Silkworm, "De Bombyce" (1669). On March 4, 1668, the Society elected Malpighi an honorary member, on the initiative of Oldenburg, and this compliment was in 1680 gracefully acknowledged by Malpighi in the shape of a present of his own portrait. In addition to the inauguration of a monument there will appear at Milan, almost immediately, "Malpighi e l' Opera sua," edited by Doctor Vallardi. Contributions to the volume have been

made by Profs. Strasburger, Virchow, Haeckel, Kölliker, Weiss, and others, while Prof. Michael Foster, Sec. R.S., furnishes a note; and it will also include several hitherto unpublished letters between Malpighi and the Royal Society. A commemorative medal has been struck, bearing on the obverse the profile effigy of the anatomist, and date. The reverse has an oak garland with inscribed legend, "It fama per orbem." The programme of Wednesday's celebration included a "Commemorazione malpighiana" by Prof. Romiti, held at the Teatro Comunale, and a special performance of Massenet's "Manon." The Royal Society sent an address of congratulation to the President of the Committee. It nominated Dr. D. H. Scott, F.R.S., honorary keeper of the Jodrell Laboratory at Kew Gardens, as its representative, but at the last moment Dr. Scott was prevented by sudden indisposition from attending.

THE German Pharmaceutical Association has awarded the first Flückiger Memorial Medal to Mr. E. M. Holmes, Curator of the Pharmaceutical Society's Museums, in recognition of his services to botany and pharmacognosy.

THE eleventh International Congress of Orientalists opened at Paris on Monday, under the presidency of M. Rambaud, the French Minister of Public Instruction.

THE collections, notes, and apparatus of the Zoological Expedition sent by Columbia University to Alaska have all been lost in the *City of Mexico*, which was wrecked while attempting to enter Queen Charlotte Sound on August 4. The members of the expedition were rescued from the ship, but the results of their season's work have been entirely lost.

WE regret to announce the deaths of Mr. William Archer, F.R.S., librarian of the National Library of Ireland; Dr. T. Bogomoloff, professor of medical chemistry in the University of Kharkoff; Dr. John Braxton Hicks, F.R.S., one of the pioneers of British work on diseases of women, and a Fellow of the Royal Society since 1862.

THE *Lancet* announces the death of Dr. Holmgren, professor of physiology in the University of Upsala. Dr. Holmgren was born in 1831, and worked for many years under Brücke, Du Bois Reymond, and Helmholtz. He was appointed to the chair of Physiology in 1864, and had the honour of establishing the first physiological institute in Sweden. He was chiefly known in this country from his researches on colour-blindness and his plan of testing the colour sense by means of wools.

THE forty-second annual exhibition of the Royal Photographic Society is now in course of preparation. It will be opened to the public on Monday, September 27, and the Saturday previous there will be a private view, followed in the evening by a conversazione at which the President, the Earl of Crawford, K.T., F.R.S., and Council will receive the Fellows, Members, and their friends. The exhibition will be open daily from 10 to 5, and on Monday, Wednesday and Saturday evenings (when lantern slides will be shown) from 7 to 10; and will close on November 13.

AT the final meeting of the International Medical Congress at Moscow on August 26, the first award of the international prize instituted by the City of Moscow was made to M. Henri Dunant, of Geneva, for the services he has rendered to humanity in the part he has played in founding the Red Cross Societies. This triennial prize, to be awarded by successive international congresses, either for the best work upon medicine or hygiene, or for eminent services rendered to suffering humanity, will amount to 5000 francs (200*l.*), representing the interest at 4 per cent. on the capital of 16,450 roubles voted by the municipality.

IT is stated that a large quantity of instruments have arrived at Dover for use in connection with some experiments in telegraphing without wires. The arrangements include experiments from Fort Burgoyne to the north of Dover Castle and other parts of the surrounding country, which offers facilities for work of this character. From the results which have been attained elsewhere it is believed the system can be successfully applied to lightships. From the position at Dover the Goodwin lightships will be made the objects of experiments under the direction of Mr. W. H. Preece. The sending apparatus will be at Fort Burgoyne, and the receiving apparatus will be moved to different parts of the district.

MOST of the subjects of address and papers brought before the meeting of the British Medical Association at Montreal were of too technical a character to be usefully chronicled in these columns. On Wednesday, September 1, the eleven sections met in the several rooms assigned to them. In the section of Medicine, Dr. Stephen Mackenzie delivered an address on the influences that have determined the progress of medicine during the preceding two and a half centuries. Mr. Christopher Heath opened the proceedings in the section of Surgery by the delivery of an address on the teaching of surgery. In the section of Public Medicine the proceedings were opened by Dr. E. P. Lachapelle, who described the progress in sanitation that had been effected in Canada down to the present time. Dr. R. M. Bucke, of London, Ontario, delivered the presidential address in the section of Psychology, on the evolution of the human mind since the days of prehistoric man. Among other addresses was one on "British Medicine in Greater Britain," by Dr. William Osler; "The Surgeon of Old in War," by Dr. W. Mitchell Banks, and "On the Progress and Results of Pathological Work," by Prof. W. Watson Cheyne. The meeting was brought to a close on September 3, with an address by Dr. Herman Biggs on the working of the health department of New York City, and the efforts made by that body to stamp out consumption. The social side of the meeting was very successful, both the members of the medical profession and private citizens displaying lavish hospitality. The Canadians appear to have done everything in their power to make this, the first meeting of the Association outside the United Kingdom, one of exceptional brilliancy in every respect. The McGill University conferred the honorary degree of Doctor of Laws on Lord Lister, Prof. Richet, Sir William Turner, Dr. Henry Barnes, Dr. Michael Foster, Dr. W. H. Gaskell, Mr. Christopher Heath, Prof. Alexander Macalister, Dr. R. Saundby, and Mr. C. G. Wheelhouse. A speech was made by Lord Aberdeen in his capacity as visitor of the University. Lord Lister, Prof. Richet, and Dr. Michael Foster returned thanks in suitable terms.

A FINE waterspout was seen off Cromer on Saturday last. Sir William Flower, who saw it from New Haven Court, says that the whole phenomena consisted of two distinct portions (1) The real waterspout; a column of water, soon dissipated into steam, rising from the sea, and caused, apparently, by a violent and greatly concentrated cyclonic action of the air. (2) A greatly elongated portion of the lower edge of an extremely dense black cloud which was hanging just over it attracted into the vortex. The two travelled along together in the direction of the prevailing wind, but the apex of the descending prolongation of the dark cloud always pointed to the centre of the ascending column, though its length, form, and direction varied from time to time.

SEVERAL sensational paragraphs have appeared in the daily press during the past few months as to an alleged method of converting silver into gold, said to have been discovered by Dr.

Stephen H. Emmens. From a letter by Dr. Emmens in the current number of the *Chemical News*, we understand he does not claim to be a modern alchemist, but merely to be able to obtain gold, or a substance which will pass muster for gold, from Mexican dollars. Four Mexican dollars were cut in halves at the U.S. Assay Office, at the request of Dr. Emmens, and four halves were assayed at the Office, with the result that no gold was found—at least, the amount was less than one part in ten thousand. The remaining set of halves of the coins "was treated in the Argentaurum Laboratory, without the addition of gold in any form, and the result was a relatively considerable production of a metal which answered to all the usual tests of gold, and was subsequently purchased as gold by the U.S. Assay Office." The weight of the gold obtained is not stated. Of course, it is possible to make the gold found the basis of very untrustworthy statements, and that appears to have been done. Apparently, however, Dr. Emmens disclaims responsibility of the newspaper reports, for what he now concludes is:—"Either some of the silver or copper in the dollars had been changed into gold or its simulacrum by my treatment; or the gold already existed in the dollars and was separated by my treatment, though not by the treatment in vogue at the U.S. Assay Office." Sir William Crookes has examined a specimen of argentaurum in the spectrograph; and he finds that it consists of gold with a fair proportion of silver and a little copper. No lines belonging to any other known element, and no unknown lines, were detected.

THE deaths from lightning in this country are, happily, very few, being only about 1 per million of the population per annum. Sometimes no sign of injury can be seen upon the victim, but in other cases marks are left upon the body, or clothes are scorched, and more than one case has been recorded where boots have been torn off the feet and nails driven out of the soles of the boots. Seldom, however, does it happen that lightning leaves such remarkable evidence of its transit as that disclosed at an inquest recently held at Hulford House, near Guildford, and reported in the *Lancet*. The evidence showed that on Wednesday, August 25, there had been a single flash of lightning and a clap of thunder, and about half an hour afterwards Major Jameson was found lying on his face in a field quite dead. Around him, in a radius of several yards, were his clothes and boots, which had been torn and scattered about in an extraordinary manner. The lightning appears to have struck him on the right side of the head, tearing his cap to pieces and burning his hair off. It then passed inside his collar down the front of his body and both legs into his boots, which were torn to pieces, and then passed into the ground, making a hole about eighteen inches in circumference and three inches deep. His collar was torn to pieces, the front of his shirt was rent into ribbons, the jacket and under-vest were literally torn to shreds, and the knickerbockers he was wearing were stripped from him and scattered on the ground. His stockings and gaiters were similarly torn in pieces, and on the boots the lightning had a remarkable effect. They were burst open, some of the brass eyelet-holes were torn out, nails were forced out, and the soles torn off. The skin had been torn off the chest, and the right leg was torn and blackened; blood was issuing from the mouth and right ear. It is difficult to account for these appalling effects, or to explain why the electric discharge should produce widely different results upon different occasions.

DR. G. HELLMAN, whose facsimile reproductions of old meteorological works are well known in this country, contributes to the *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* a short paper on the beginnings of observations of terrestrial magnetism. He traces the earliest observations of magnetic declination along two distinct lines: one due to the interest excited amongst seamen by Columbus's discovery, on September 13, 1492, of the changes in the variation of the compass, and another due to landsmen's efforts to construct an accurate portable sundial. A list of ten determinations of magnetic declination is given, beginning with Georg Hartmann at Rome about 1510 (6° E.), and ending with Gerhard Mercator on the island of Walcheren about 1546. The work of the remarkable João de Castro seems by far the best: he gives decl. 7½° E. at Lisbon in 1538. The first English observations are those of William Borough, of Limehouse, published in his "Discourse of the Variation of the Compass or Magnetical Needle," &c., in the year 1581, now a very rare book.

WE have received from M. Durand-Gréville a paper entitled "Les grains et le burster d'Australie," being an excerpt from the *Annales* of the French Meteorological Office for 1895 (just published). This is one of a series of valuable discussions on violent squalls in various parts of the world, which it is the aim of M. Durand-Gréville to show are very similar in their nature, although differing in their name and in their secondary characteristics (temperature, humidity, &c.). He points out that there are two different kinds of barometric depressions: (1) where the variations of pressure, temperature, &c., are gradual; and (2) where these elements change abruptly along a radial line running nearly to the southwards. In the rear of the passage of this radial line from west to east an area of high pressure and violent winds obtain. It is to this special feature that M. Durand-Gréville has paid particular attention, and his views seem to be consistent with those adopted by investigators in this country and in Germany, when dealing with secondary and especially the so-called V-shaped depressions, which often accompany or immediately follow a primary atmospherical disturbance.

PROF. DR. JOHAN HJORT publishes in *Naturen* a more or less popular *résumé* of some of the recent physical and biological researches in the Norwegian Sea. The most important work not published before consists of a discussion of two extremely valuable sets of temperature and salinity observations made between Norway and Iceland during March and April 1897. These serve to show the form and extent of the cold streams from the east of Iceland at a time when it is rarely possible to get any information, precisely the time when that information is of the highest importance.

M. E. A. MARTEL gives, in the *Comptes rendus de la Société de Geographie*, a summary of his work in Speleology during 1896. Six series of caverns were explored in France, two in the Island of Majorca, and the famous Salitre grotto in Catalonia. The Foiba de Pisino in Istria, visited in 1893, was re-examined, and some remarkable observations made on the changes produced in a subterranean lake by continued heavy rains. Under certain conditions the hydrostatic pressure in the underground syphon feeding the Foiba must amount to at least seven atmospheres, doubtless producing important mechanical and chemical changes.

DR. RUDOLF ZUBER, professor of geology in the University of Lemberg, has recently published a map of the petroleum region of Galicia, with a paper, in the German language, on the economical geology of the district. As he points out in the introduction to his paper, the region is one of surpassing geological interest and difficulty, while the language offers a greater barrier, both to travel and to a study of the literature, than is the case in many regions much further afield. Dr. Zuber's paper is therefore all the more welcome. It contains a classification of the oil-bearing strata based upon local characteristics, which amply serves the purposes of the local industry without

committing itself upon the much more difficult question of their precise age.

IN a previous note in NATURE (p. 205), attention was called to Dr. Giovanni Vailati's studies on the statical notions of Archimedes. We have now received a reprint of a further paper by the same writer (*Atti della R. Accademia delle Scienze di Torino*, xxxii.), dealing with the "Principle of Virtual Work from Aristotle to Hero of Alexandria." From an examination of the *Mechanika Problemata* of Aristotle, the *Baroulkos* of Hero, and a Latin thirteenth century manuscript, *De ponderibus*, attributed to Giordano Nemorario, it appears that this principle, though commonly supposed to have been discovered about the end of the fifteenth century, was in reality known to the Greeks. In the work of Hero, Dr. Vailati finds not only distinct statements of the relations between forces and the displacements produced by them, but also applications of the principle to various machines, including pulleys. From this evidence the author attributes to the Greeks a knowledge of the subject considerably in advance of that evinced by the sixteenth-century writers on statics.

A PHOTO-VOLTAIC theory of photographic processes forms the subject of a lengthy investigation, by H. Luggin (*Zeitschrift für physikalische Chemie*, xxiii. 4). It was shown by Becquerel, in 1839, that the haloids of silver are capable, under certain conditions, of giving rise to photo-voltaic currents; and Herr Luggin finds a close connection between these currents and the decompositions which give rise to photographs. A remarkable feature is the reversal of the voltaic current which occurs when a certain potential has been reached, a consequence of which is that the same electrode is capable, according to circumstances, of giving rise to currents of opposite signs, and these Herr Luggin distinguishes as "normal" and "solarisation currents." The former are the more susceptible to blue, and the latter to yellow light. The whole investigation tends to throw light on the much-debated theories of photographic action, by showing that both the latent picture of photographic negatives and the visible transformations of the printing-out process have their counterpart in definite photo-voltaic phenomena.

AN interesting account of the earthquake of Aïdin (Asia Minor) on August 19, 1895, is given by Dr. G. Agamennone in Gerland's *Beiträge zur Geophysik*. The epicentre is situated at or close to the village of Imamkeuy, which is 6 km. east of Aïdin, and the majority of damaged buildings lie within an area about 50 km. long and 20 km. broad, the longer axis of the area being roughly parallel to the valley of the Menderes. The disturbance was registered by the Vicentini microseismograph at Padua (1570 km. from the origin), and the horizontal pendulum at Strassburg (2010 km.). The usual secondary phenomena, such as landslips, fissures in the ground, and the derangement of the underground water-system, occurred in the epicentral area; and some of the landslips gave rise to thick clouds of dust, which hung in the air for several hours, and were then carried by the wind to the south side of the valley and deposited on the adjoining mountains.

WE have heard often enough that loud and continued explosions produce rain, and the recollection of rain-making experiments based upon this apparent connection is still with us. Now comes a report from Mr. Germain, United States Consul at Zürich, on the prevention of hailstorms by the same means that have been used to encourage a downfall of rain. It appears that Mr. Albert Stiger, burgomaster of Windisch-Freistritz (Lower Steirmark, Austria), owns extensive vineyards situated on the southern slopes of the Bacher Mountains, a locality often visited by destructive hailstorms. To protect his vines from hail, he decided to try the shooting or explosive system to scatter the clouds and drive away approaching hail or heavy rain storms. Six stations were therefore erected on the six most prominent summits surrounding the locality, and commanding a territory of about two miles in extent. These stations sheltered ten heavy mortars each. Upon the slightest indication of a storm the mortars were immediately manned and loaded with 120 grams of powder each—about 4¼ ounces—and shooting commenced simultaneously and continued regularly out of the sixty mortars until the clouds were scattered and the storm had blown over. These experiments were anxiously watched by the citizens of Windisch-Freistritz last summer. Threatening black clouds made their appearance over the summits of the Bacher Mountains; at a given signal all the mortars were fired off, and the continuous detonations in a few moments caused a sudden reaction in the movements of the clouds. It is said that the cloud opened up funnel-like, the mouth of the funnel began to rise in the form of consecutive rings, expanding gradually until all of the cloud scattered and entirely disappeared. There was no hail, or even a sudden downpour of rain. The same experience was gone through six times during the summer, and proved a successful preventive in each case. We await the views of Austrian meteorologists upon these experiments; meanwhile, rain-makers who have put their trust in explosions must hide their diminished heads before the rain-dispersers.

IT has long been known that in the Pondicherry district of Peninsular India there occur Cretaceous rocks with a peculiar fauna, but though studied by such palæontologists as Forbes, d'Orbigny, and Stoliczka, the exact horizon of these beds has remained uncertain, they having been variously placed in the lower, the middle, and the upper parts of the Cretaceous system. This question may be taken as finally settled by Dr. F. Kossmatt (*Records Geol. Survey India*, xxx. 2, May 1897), who, applying the increased modern knowledge of the succession of life-forms in the Cretaceous to these beds, divides them into three divisions, of which the two lower represent the Upper Senonian (highest part of the English chalk) and the upper the Danian. The general interest of Dr. Kossmatt's paper lies, however, in the side-issues which it raises. Similar beds are known in Natal, Madagascar, Assam, Borneo, Yesso, Vancouver and Quiriquina Island, Chili. The similarity of the fauna in these beds shows the Pacific Ocean to have formed a well-defined province in Cretaceous times, separated by a barrier from the Mediterranean Ocean which extended through Europe and Central Asia. Somewhere in the Atlantic area, however, this barrier was imperfect, and a migration of Pacific forms into the Mediterranean took place, and a reverse migration to a smaller extent. By a careful study of these forms, Dr. Kossmatt arrives at a number of interesting conclusions: (1) The time required for the dispersal of a species was insignificant beside the time required for a measurable amount of sedimentation, so that in this case homotaxis means contemporaneity. (2) As the Ammonites were dispersed, they underwent definite specific changes, so that their wide distribution as fossils cannot be explained as the result of the flotation of their *dead* shells, as has been suggested by Dr. Walther. (3) The Ammonites seem to have possessed greater capacity for distribution than other groups. (4) The appearance of a new fauna in several cases coincides, everywhere, with an overlap, indicating an extension of the ocean over the land-surface: this repeated "positive displacement" of shore-lines is as characteristic of the Cretaceous all over the world, as the opposite displacement is of the beginning of the Tertiary; the Pondicherry beds, for example, rest directly on the Archæan crystallines of the Peninsula.

THE latest number of the *Journal* of the Asiatic Society of Bengal (vol. lxv. part II. No. 1, 1897, p. 345) is entirely taken up with the ninth descriptive catalogue of "Materials for a

Flora of the Malayan Peninsula," by Dr. George King, F.R.S. The publication of these very valuable contributions to botanical science was commenced more than seven years ago, but pressure of other work has prevented Dr. King from making as rapid progress as he desired. In the present part the account of the Calyciflorae is begun, and it is hoped that one more contribution similar in size to that just published will suffice to complete the Calyciflorae, and bring the whole series about half-way towards completion.

DURING the Norwegian North-Atlantic Expedition (1876-78), Prof. G. O. Sars collected from the surface a quantity of plankton containing many algæ, especially Diatoms. He described the most characteristic forms, and early last year handed over the samples for more detailed study to H. H. Gran, whose description of the material has now been published in Memoir xxiv. of the "General Report of the Norwegian North-Atlantic Expedition" (Christiania: Grondahl and Sons), printed in both Norse and English. The study of the material shows that the water of the Atlantic is especially characterised by *Chætoceros decipiens*, *atlanticum*, *boreale* and *Brightwellii*, and by several *Rhizosolenia* species. The water of the Polar Sea during summer is characterised by *Chætoceros furcellatum*, *Fragilaria oceanica*, and *Thallassiosira* species. From the contents of the samples, however, no decided boundary could be drawn, either because the ocean currents mix to a certain extent with one another, or because the Diatomaceæ have the power of rising or sinking from one stratum of water to another, independently of the currents. Mr. Gran states that he has obtained evidence which clearly points to the occurrence of the latter possibility.

THE following are among noteworthy papers and other publications which have been received during the past few days:—The letters exchanged between the two mathematicians Jakob Steiner and Ludwig Schläfli from the year 1848 to 1856 are printed in the *Mittheilungen der Naturforschenden Gesellschaft in Bern* (1896), edited by Prof. J. H. Graf.—Mr. Bernard Quaritch has just issued two catalogues (Nos. 170, 172) of scientific books, and Transactions of learned societies, offered for sale by him. We notice in the list a set of *Challenger* Expedition Reports for sale for 67*l.* 10*s.* Scientific book-buyers and librarians should certainly see Mr. Quaritch's catalogues.—Part v. of "Fresenius' Quantitative Analysis" (vol ii.), translated by Mr. Chas. E. Groves, F.R.S., has just been published by Messrs. J. and A. Churchill.

THE additions to the Zoological Society's Gardens during the past week include a Huanaco (*Lama huanacos*, ♀) from Bolivia, presented by Mr. W. J. Huxley; a —— Mouse (*Phyllotis griseoflavus*), two Chimachima Milvagos (*Milvago chimachima*), three Pileated Song Sparrows (*Zonotrichia pileata*), three Yellowish Finches (*Sycalis luteola*), two Bay Cow Birds (*Molothrus bodius*), a Yellow Troupial (*Xanthosomus flavus*) from Argentina, three West African Love Birds (*Agapornis pullaria*) from West Africa, presented by Mr. E. A. Fitzgerald; a Malabar Squirrel (*Sciurus maximus*) from India, presented by Mr. J. E. Summers; two Rough-legged Buzzards (*Archibuteo lagopus*), European, presented by Mr. H. W. Feilden; a European Tortoise (*Emys orbicularis*) European, presented by Mr. Duncan Dickens; eleven Green Lizards (*Lacerta viridis*), two Sand Lizards (*Lacerta agilis*), a Wall Lizard (*Lacerta muralis*), European, presented by Mr. C. W. Tytheridge; a Crested Porcupine (*Hystrix cristata*), three White Storks (*Ciconia alba*), a Greater Black-backed Gull (*Larus marinus*), a Herring Gull (*Larus argentatus*), a Common Night Heron (*Nycticorax griseus*), two Buzzards (*Buteo vulgaris*), European, two Ypecaha Rails (*Aramides ypecaha*) from South America, deposited; a Barbary Wild Sheep (*Ovis tragelaphus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

DEDICATION OF THE YERKES OBSERVATORY.—The formal dedication of the Yerkes Observatory will take place on October 21–22, and not on October 1, as previously announced. In connection with the dedication, a series of conferences on astronomical and astrophysical subjects will be held at the observatory on October 18, 19, 20, and 21. The provisional programme for these meetings is published in the August number of the *Astrophysical Journal*.

SOUTHERN DOUBLE STARS.—Profs. W. H. Pickering and S. I. Bailey have taken advantage of the steady air of Arequipa, and the consequent good definition, to search for close double stars in the southern skies. All the stars of the sixth magnitude and brighter, south of declination −30°, have been examined for close companions, with the 13-inch Boyden telescope. Nearly one hundred and fifty stars were thus found to have companions at distances not exceeding thirty seconds of arc, not counting stars already announced as double in the catalogues of Herschel and Russell. The numbers of these stars in the Argentine General Catalogue are recorded in *Harvard College Observatory Circular*, No. 18.

VARIABLE STARS IN CLUSTERS.—The important fact that a large number of individual stars in certain globular star clusters are variable, sometimes to the extent of two magnitudes or more, was announced in *Harvard College Observatory Circular* (No. 2) in November 1895 (see NATURE, vol. liii. p. 91), and was again referred to in May 1896 (NATURE, vol. liv. p. 108). A *Circular* (No. 18) just received from the observatory, announces that Prof. S. I. Bailey has found many more of these, bringing their total number up to 310. The greatest number of variables occur in the cluster No. 5272 in the New General Catalogue (Messier 3), as many as 113 stars in this cluster having been found to fluctuate in light. In N.G.C. 5904 (Messier 5), 63 stars have been proved to be variable, and in N.G.C. 5139 (ω Centauri) 60 stars appear to undergo light-changes. It is remarkable that while in the cluster Messier 3 about one-ninth of the stars are variable, in other clusters, for instance the great cluster in Hercules (N.G.C. 6205), not a single variable was found out of nearly two thousand stars examined.

THE MAGNITUDES OF THE ASTEROIDS.—An interesting history of the asteroids and the questions to which they give rise, is given by Herr G. Huber in the *Mittheilungen der Naturforschenden Gesellschaft in Bern* for the year 1896. The mean magnitude at opposition of the first four hundred minor planets are tabulated in groups of fifty as follows, the column marked Mag. 8 including asteroids of magnitudes 8 to 8·9, while the column marked Mag. 9 includes all from magnitude 9 to mag. 9·9, and so on for other magnitudes.

Numbers of asteroids.	Brighter than Mag. 8	Mag. 8	Mag. 9	Mag. 10	Mag. 11	Mag. 12	Fainter than Mag. 12
1– 50	2	7	17	15	7	2	—
51–100	—	—	2	19	23	5	1
101–150	—	—	—	15	27	8	—
151–200	—	—	1	4	20	20	5
201–250	—	—	—	3	18	17	12
251–300	—	—	—	1	7	13	29
301–350	—	—	2	2	8	21	17
351–400	—	—	—	2	4	13	31
Total ...	2	7	22	61	114	99	95

The table shows clearly that the asteroids discovered in recent years, namely those from No. 200 to No. 400, are mainly of the twelfth magnitude, or even fainter than that.

A NEW NEBULA PHOTOGRAPH.—A brilliant picture of the nebula Herschel V 15 Cygni (No. 6992 in the New General Catalogue), reproduced from a photograph obtained by Dr. Isaac Roberts, F.R.S., with an exposure of 2h. 55m., appears in the September number of *Knowledge*. The nebula is a wave-like brush of light, measuring about eighty minutes of arc in length,

and presenting a torn appearance in places. Faint nebulous stars are immersed in the wave structure, and here and there the luminous material gives indications of condensation. Surrounding the nebula, and strewn over its surface are numerous stars, which are, however, apparently not physically connected with the general mass. Referring to the structure of the nebula in relation to the methods of stellar evolution, Dr. Roberts says:—"The general appearance of the nebula is that of precipitation of invisible matter—either gaseous or of dust particles—which exists in space as clouds of vast extent. . . . We know of no body whatever existing in space which has no motion of translation; but whether this invisible matter is in motion or at rest, it could be run into by another body that is in motion, with the result that whirlpool motions would be set up that would eventually develop into nebulæ of various forms, such as those which have already been, by photography, shown to exist. If, on the other hand, the clouds themselves are in motion and collide with each other, then vortical motion would be set up over large areas, giving rise by progress of development to such nebulæ as are represented by the photograph. This nebula shows signs of fission, and may pass in its process of development into symmetrical nebulæ and into stars, and again from stars into—what?"

A SUCCESSFUL EXPERIMENT IN LOBSTER-REARING.

ATTEMPTS to rear the larvæ of the lobster in this country have never hitherto succeeded. Several years ago Captain Dannevig reared some at Arendal, and published a description of his results, but no other instance of success with the European species has been recorded. In America the rearing of the American species has been successfully accomplished at Wood's Hole by Mr. F. H. Herrick, and a masterly description of the stages of the development, with extremely fine illustrations, was recently published by him as a number of the Fish Commission Bulletin. At the establishment of the Marine Biological Association at Plymouth attempts to rear lobster larvæ have been made, but never with success. In the tanks the larvæ invariably died after a few days, and when the hulk of a superannuated fishing-vessel was fitted up, provided with a well to which the water could have access, and moored in the Sound, she unfortunately sank at her moorings with the thousands of larvæ which she contained. It is therefore a fact not without interest and importance, that the difficult feat has been accomplished with some success during the present season at Falmouth. During the last two or three years, experiments in oyster and lobster culture have been carried on at that place under the auspices of a committee of the Royal Cornwall Polytechnic Society, the cost of the work being defrayed from a fund collected by private subscription, supplemented by grants from the Technical Instruction Committee. Until the commencement of this year the experiments were directed by Mr. Rupert Vallentin, who designed a large floating box 14 feet by 6 feet in area, by 3 feet in depth, provided with windows covered with metal gratings, for the purpose of rearing lobster larvæ. This box is moored in a corner of the docks where the water seemed quite pure. Last year no success was obtained, owing to an injury to the box. During the present season the experiments have been under the direction of Mr. J. T. Cunningham, the Lecturer on Fisheries for the county. Berried female lobsters were first placed in the box on and about June 24, to the number of three. Larvæ were first seen on July 6, and were fed on minced fish, but the number rapidly diminished. Seven more berried females were put in on July 16, and since that time there has always been a considerable number of larvæ alive in the box; some of the females have not yet hatched all their eggs (August 22). Since July 16 the only food supplied has been the crushed and pounded flesh of the edible crab, the females of which could be obtained regularly at small cost. It was found essential to feed the larvæ every day. As usual there was considerable mortality, and the larvæ showed their inveterate tendency to cannibalism; but a few specimens have passed through the various stages of their metamorphosis. Students of Herrick's memoir are aware that the final condition is reached, not considering certain minor features of little importance, at the fourth stage. The first stage is characterised by the entire absence of abdominal appendages, and the presence of the thoracic exopodites. After the second moult four pairs of abdominal pleopods are developed, at the third the uropods on the sixth abdominal somite are added, and at the fourth moult the exopodites are lost, and the antennary flagella appear. A specimen in the third stage was taken from the hatching-box at Falmouth on August 12, and one in the fourth stage on August 22.

The rearing of lobster larvæ may always remain too difficult and too expensive to be of any practical importance, and the survival of a single specimen may appear to be a small success. But there is every probability that other specimens will reach the same or later stages in the course of the experiment, and, considering the large amount of attention that the problem has attracted, the result above described is worthy of record.

THE BRITISH ASSOCIATION.

SECTION K.

BOTANY.

OPENING ADDRESS BY PROF. H. MARSHALL WARD, SC.D., F.R.S., F.L.S., PRESIDENT OF THE SECTION.

THE competent historian of our branch of science will have no lack of materials when he comes to review the progress of botany during the latter half of the Victorian reign. The task of doing justice to the work in phanerogamic botany alone, under the leadership of men like Hooker, Asa Gray, Mueller, Engler, Warming, and the army of systematists so busily shifting the frontiers of the various natural groups of flowering plants, will need able hands for satisfactory treatment. A mere sketch of the influence of Kew, the principal centre of systematic botany, and of the active contingents of Indian and colonial botanists working under its inspiration, will alone require an important chapter, and it will need full knowledge and a wide vision to avoid inadequacy of treatment of its powerful stimulus on all departments of post-Darwinian botany. The "Genera Plantarum," the "British Flora," the "Flora of India," suffice to remind us of the prestige of England in systematic botany, and the influence of the large and growing library of local and colonial floras we owe to the labours of Bentham, Trimen, Clarke, Oliver, Baker, Hemsley, Brandis, King, Gamble, Balfour, and the present Director of Kew, is more than merely imperial.

The progress in Europe and America of the other departments of botany has been no less remarkable, and indeed histology and anatomy, comparative morphology, and the physiology and pathology of plants have perhaps advanced even more rapidly, because the ground was newer. In England the work done at Cambridge, South Kensington and elsewhere, and the publications in the "Annals of Botany" and other journals sufficiently bear witness to this. A consequence has been the specialisation which must soon be openly recognised—as it already is tacitly—in botany as in zoological and other branches of science.

No note has been more clearly sounded than this during the past twenty-five years, as is evident to all who have seen the origin, rise, and progress of our modern laboratories, special journals, and even the gradual subdivisions of this Association. We may deplore this, as some deplore the departure of the days when a naturalist was expected to teach geology, zoology, and botany as a matter of course; but the inevitable must come. Already the establishment of bacteriological laboratories and a huge special literature, of zymo-technical laboratories and courses on the study of yeasts and mould fungi, of agricultural stations, forestry and dairy schools, and so on—all these are signs of the inexorable results of progress.

There are disadvantages, as the various *Centralblätter* and special journals show; for hurried work and feverish contentions for priority are apt to accompany these subdivisions of labour; and those of us who are most intimately concerned with the teaching of botany will do well to take heed of these signs of our times, and distinguish between the healthy specialisation inevitably due to the sheer weight and magnitude of our subject, and that incident on other movements and arising from other causes. The teaching and training in a university or school need not be narrow because its research-laboratories are famous for special work.

One powerful cause of modern specialisation is utility. The development of industries like brewing, dyeing, forestry, agri-

culture, with their special demands on botany, shows one phase; the progress of bacteriology, palæontology, pathology, economic and geographical botany, all asking special questions, suggests another. In each case men are encouraged to go more and more deeply into the particular problems raised.

Identification of flowers in Egyptian tombs, of pieces of wood in Roman excavations, the sorting of hay-grasses for analysis, or seeds in the warehouses; the special classifications of seedlings used by foresters, or of trees in winter, and so on, all afford examples. It is carried far, as witness the immense labour it is found worth while for experts to devote to the microscopic analysis of seeds and fruits liable to adulteration, or to the recognition of the markings in imprints of fossil leaves, or of characters like leaf-scars, bud-scales, lenticels, and so on, by which trees may be determined even from bits of twigs.

If we look at the great groups of plants from a broad point of view, it is remarkable that the Fungi and the Phanerogams occupy public attention on quite other grounds than do the Algæ, Mosses, and Ferns. Algæ are especially a physiologists' group, employed in questions on nutrition, reproduction, and cell-division and growth; the Bryophyta and Pteridophyta are, on the other hand, the domain of the morphologist concerned with academical questions such as the Alternation of Generations and the Evolution of the higher plants.

Fungi and Phanerogams, while equally or even more employed by specialists in Morphology and Physiology, appeal widely to general interests, and evidently on the ground of utility. Without saying that this enhances the importance of either group, it certainly does induce scientific attention to them.

I need hardly say that comparisons of the kind I am making, invidious though they may appear, in no way imply detraction from the highest honour deservedly paid to men who, like Thuret, Schmitz, and Thwaites in the past, and Bornet, Wille, and Klebs in the present, have done and are doing so much to advance our academical knowledge of the Algæ; and Klebs' recent masterpiece of sustained physiological work, indeed, promises to be one of the most fruitful contributions to the study of variation that even this century has produced. Nor must we in England forget Farmer's work on *Ascophyllum*, and on the nuclei and cell-divisions of *Hepaticæ*; and while Bower and Campbell have laid bare by their indefatigable labours the histological details of the Mosses and Vascular Cryptogams, and carried the questions of Alternation of Generations and the evolution of these plants so far, that it would almost seem little remains to be done with Hoffmeister's brilliant conception but to ask whither it is leading us; the genetic relationships have become so clear, even to the details, that the recent discovery by Ikeno and Hirase of spermatozoids in the pollen tubes of *Cycas* and *Gingko* almost loses its power of surprising us, because the facts fit in so well with what was already taught us by these and other workers.

It is impossible to over-estimate the importance of these comparative studies, not only of the recent Vascular Cryptogams, but also of the Fossil Pteridophyta, which, in the hands of Williamson, Scott, and Seward, are yielding at every turn new building stones and explanatory charts of the edifice of Evolution on the lines laid down by Darwin.

All these matters, however, serve to prove my present contention, that the groups referred to do not much concern the general public; whereas, on turning to the Fungi and Phanerogams, we find quite a different state of affairs. It is very significant that a group like the Fungi should have attracted so much scientific attention, and aroused popular interest at the same time. In addition to their importance from more academical points of view—for they claim the attention of morphologist and physiologist as much as any group, as the work of Wager, Massee, Trow, Hartog, and Harper, and an army of continental investigators, with Brefeld, Von Tavel, Magnus, &c., at their head, has shown—the Fungi appeal to wider interests on many grounds, but especially on that of utility. The fact that Fungi affects our lives directly has been driven home, and whether as poisons or foods, destructive moulds or fermentation-agents, parasitic mildews or disease germs, they occupy more of public interest than all other Cryptogams together, the flowering plants alone rivalling them in this respect.

A marked feature of the period we live in will be the great advances made in our knowledge of the uses of plants. Of course, this development of Economic Botany has gone hand in hand with the progress of Geographical Botany and the extension of our planting and other interests in the colonies, but the useful applications of Botany to the processes of home industries are increasing also.

The information acquired by travellers exploring new countries, by orchid-collectors, prospectors for new fibres or india-rubber, or resulting from the experiences of planters, foresters, and observant people, living abroad, has a value in money which does not here concern us; but it has also a value to science, for the facts collected, the specimens brought home, the processes observed, the results of analyses, the suggestions gathered—in short, the puzzles propounded by these wanderers—all stimulate research, and so have a value not to be expressed in terms of money.

The two react mutually, and I am convinced that the stimulus of the questions asked by commerce of botanical science has had, and is having, an important effect in promoting its advance. The best proof to be given of the converse—that Botany is really useful to commerce—is afforded by the ever-increasing demands for answers to the questions of the practical man. At the risk of touching the sensibilities of those who maintain that a university should regard only the purely academical aspects of a science, I propose to discuss some cases where the reciprocal influences of applied, or useful, and purely academic or useless botany—useless because no use has yet been made of it, as some one has wittily put it—have resulted in gain to both. In doing this, I wish to clearly state my conviction that no scientific man should be guided or restricted in his investigations by any considerations whatever as to the commercial or money value of his results; to patent a method of cultivating a bacillus, to keep secret the composition of a nutritive medium, to withhold any evidence, is anti-scientific, for by the nature of the case it is calculated to prevent improvement—*i.e.* to impede progress. It is not implied that there is anything intrinsically wrong in protecting a discovery: all I urge is that it is opposed to the scientific spirit.

But the fact that a scientific spirit is found to have a commercial value also—for instance, Wehmer's discovery that the mould fungus, *Citryomyces*, will convert 50 per cent. of the sugar in a saccharine solution to the commercially valuable citric acid: or Matruchot's success in germinating the spores of the mushroom, and in sending pure cultures of that valuable agaric into the market—is no argument against the scientific value of the research. There are in agriculture, forestry, and commerce generally, innumerable and important questions for solution, the investigation of which will need all the powers of careful observation, industrious recording, and thoughtful deduction of which a scientific man is capable. But while I emphatically regard these and similar problems as worthy the attention of botanists, and recognise frankly their commercial importance, I want to carefully and distinctly warn all my hearers against supposing that their solution should be attempted simply because they have a commercial value.

It is because they are so full of promise as scientific problems, that I think it no valid argument against their importance to theoretical science that they have been suggested in practice. In all these matters it seems to me we should recognise that practical men are doing us a service in setting questions, because they set them definitely. In the attempt to solve these problems we may be sure science will gain, and if commerce gains also, so much the better for commerce, and indirectly for us. But that is not the same thing as directly interesting ourselves in the commercial value of the answer. This is not our function, and our advice and researches are the more valuable to commerce the less we are concerned with it.

It is clear that the magnitude of the subject referred to is far beyond the measure of our purpose to-day, and I shall restrict myself to a short review of some advances in our knowledge of the Fungi made during the last three decades.

Little more than thirty years ago we knew practically nothing of the life-history of a fungus, nothing of parasitism, of infectious diseases, or even of fermentation, and many botanical ideas now familiar to most educated persons were as yet unborn. Our knowledge of the physiology of nutrition was in its infancy, even the significance of starches and sugars in the green-plant being as yet not understood; root-hairs and their importance were hardly spoken of; words like *heterœcism*, *symbiosis*, *mycorhiza*, &c., did not exist, or the complex ideas they now connote were not evolved. When we reflect on these facts, and remember that *bacteria* were as yet merely curious "animalculæ," that rusts and smuts were generally supposed to be

emanations of diseased states, and that "spontaneous generation" was a hydra not yet destroyed, we obtain some notion of the condition of this subject about 1860.

As with other groups of plants, so with the Fungi, the first studies were those of collecting, naming and classifying, and prior to 1850 the few botanists who concerned themselves with these cryptogams at all were systematists. So far as the larger fungi are concerned, the classification attained a high degree of perfection from the point of view of an orderly arrangement of natural objects, and the student of to day may well look back at the keen observation and terse, vivid descriptions of these older naturalists, which stands in sharp contrast to much of the more slovenly and hurried descriptive work which followed.

It may be remembered that even now we rely mainly on the descriptions and system of Fries (1821-1849) for our grouping of the forms alone considered as fungi by most people, and indeed we may regard him as having done for fungi what Linnæus did for flowering plants.

But, as you are aware, a large proportion of the Fungi are microscopic, and in spite of the conscientious and beautiful work of several earlier observers, among whom Corda stands preeminent, the classification and descriptions of the thousands of forms were rapidly bringing the subject into chaos.

The dawn of a new era in Mycology was preparing, however. A few isolated observers had already begun the study of the development of Fungi, but their work was neglected, till Persoon and Ehrenberg at the beginning of this century again brought the subject into prominence, and then came a series of discoveries destined to stimulate work in quite other directions.

The Tulasnes may be said to have brought the old period to a close, and prepared the way for the new one; they combined the powers of accurate observation with a marvellous faculty of delineation, and applied the anatomical method to the study of fungi with more success than ever before. Their new departure, however, is more evident in their selection of the parasitic fungi for study, and you all know how indispensable we still find their drawings of the germinating spores of the Smuts and Rusts. It is difficult to say which of their works is the most masterly, but probably the study of the life-history of *Claviceps purpurea* deserves first place, though successive memoirs on the Uredineæ, Ustilagineæ, Peronosporeæ, Tuberaceæ, and then that magnificent work, the "Selecta Fungorum Carpologia," cannot be forgotten.

In England, Berkeley was the man to link the period previous to 1860 with the present epoch. A systematist and observer of high power, and with a rare faculty for appreciating the labours of others, this grand old naturalist did work of unequalled value for the period, and the student who wishes to learn what was the state of mycology about this time will find it nowhere better presented than in Berkeley's works, one of which—his "Introduction to Cryptogamic Botany"—is a classic.

Like all classifications in botany, however, that of the fungi now took two courses: one in the hands of those who collated names and herbarium-specimens, and proposed cut and dried, but necessary and from a certain point of view very complete systems of classification, and those who, generalising from actual cultures and observation of the living plant, proposed outline schemes, the details of which should be filled in by their successors.

No one who knows the history of botany during this century will deny that it is to the genius of De Bary that we owe the foundation of modern mycology, for it was this young Alsatian who, though profoundly influenced by the work of Von Mohl and Schleiden on the one hand, and of Unger and the Tulasnes on the other, refused to follow either the school of the phytotomists—though his laborious "Comparative Anatomy of the Ferns and Phanerogams" shows how well equipped he was to be a leader in that direction—or that of the anatomical mycologists. No doubt the influence of Cohn, Pringsheim, and others of that new army of microscopists who were teaching the necessity of continued observation of living organisms under the microscope, can be traced in impelling De Bary to abandon the older methods; but his own unquestionable originality of thought and method came out very early in his investigations on the Lower Algæ and Fungi. If I may compare a branch of science to an arm of the sea, we may look on De Bary's influence as that of a Triton rising to a surface but little disturbed by currents and eddies. The sudden upheaval of his genius set that sea rolling in huge waves, the play of which is not yet exhausted.

The birth and flow of the new ideas, expressed in far-reaching generalisations and suggestions which are still moving, led to the revolutions in our notions of polymorphism, parasitism, and the real nature of infection and epidemics. His development of the meaning of sexuality in Fungi, his startling discovery of heterœcism, his clear exposition of symbiosis, and even his cautious and almost wondering whisper of chemotaxis were all fruitful, and although the questions of enzyme-action and fermentation were not made peculiarly his own, he saw the significance of these and many other phenomena now grown so important, and here, as elsewhere, thought clearly and boldly, and criticised fearlessly with full knowledge and justice.

I do not propose to occupy our time with even a sketch of the history of these and other ideas of this great botanist; but rather pass to the consideration of a few of the results of some of them in the hands of later workers, in schools now far developed and widely independent of one another, but all deeply indebted to the genial little man whom we so loved and revered.

The most marked feature noticed in the founding of the new schemes of classification of the Fungi was the influence of the results of pure and continuous cultures introduced by De Bary. The effect on those who followed can best be traced by examining the great systems of subsequent workers, led by Brefeld and Van Tieghem, and the writings of our modern systematists. This task is beyond my present scheme, however, and there is only time to remind you of the fungus floras of Saccardo, Constantin, Massee, and others, in this connection.

The word "fermentation" usually recalls the ordinary processes concerned in the brewing of beer and the making of wines and spirits; but we must not forget that the word connotes all decompositions or alterations in the composition of organic substances induced by the life-activities of Fungi, and that it is a mere accident which brings alcoholic fermentation especially into prominence.

I ventured some time ago to term alcoholic fermentation the oldest form of microscopic gardening practised by man, and this seems justified by what we know of the very various and very ancient processes in this connection.

But the making of beers, wines, and spirits, as we understand them, constitutes but a small part of the province of fermentation, and even when we have added cider and perry, ginger-beer, and the various herb and spruce beers to the list, we have by no means exhausted the tale of fermented drinks. Palm-wines of various kinds, toddy, pulque, arrack, kava, and a number of tropical alcoholic fermented liquors have to be included, and the koumiss and kephir of the Caucasus, the curious Russian kwass, the Japanese saké, and allied rice-preparations must be mentioned, to say nothing of the now almost forgotten birch-beer, mead and metheglin, and various other strange fermented decoctions of our forefathers' time, or confined to out-of-the-way localities.

In all these cases the same principal facts come out—a saccharine liquid is exposed to the destructive action of fungi, which decompose it, and we drink the altered or fermented liquor. As is now well known, the principal agents in these fermentations are certain lower forms of fungi called yeasts, and since Leeuwenhoeck, of Delft, discovered the yeast cells two hundred years ago, and La Tour, Schwann, and Kützing (about 1840) recognised them as budding plants, living on the sugar of the liquid, and which must be classed as Fungi, the way was paved for two totally different inquiries concerning yeast.

One of these was the fruitful one instigated by Pasteur's genius about 1860, and concerned the functions of yeast in fermentation. In the hands of Naegeli, Brefeld, and others abroad, and of A. J. and Horace Brown and Morris and others in England, Pasteur's line of research was rapidly developed, and, as we all know, has had a wide influence in stimulating investigation and in suggesting new ideas; and although the theory of alcoholic fermentation itself has not withstood all the criticism brought against it, and seems destined to receive its severest blow this year by E. Buchner's isolation of the alcoholic enzyme, we must always honour the school which nursed it.

The divergent line of inquiry turned on the origin and morphological nature of yeast. What kind of a fungus is yeast, and how many kinds or species of yeasts are there?

Reess, in 1870, showed the first steps on this long path of inquiry, and gave the name *Saccharomyces* to the fungus, showing that several species or forms existed, some of which develop definite spores.

In 1883, Hansen, of Copenhagen, taking advantage of the strict methods of culture introduced and improved by De Bary, Brefeld, Klebs, and other botanists, had shown that by cultivating yeast on solid media from a single spore it was possible to obtain constant types of pure yeasts, each with its own peculiar properties.

One consequence of Hansen's labours was that it now became possible for every brewer to work with a yeast of uniform type instead of with haphazard mixtures, in which serious disease forms might predominate and injure the beer. Another consequence soon appeared in Hansen's accurate diagnosis of the specific or varietal characters of each form of yeast, and among other things he showed that a true yeast may have a mycelial stage of development. The question of the nucleus of the yeast-cell, on which Mr. Wager will enlighten us, has also occupied much attention, as have also the details of spore formation.

Meanwhile, a question of very general theoretical interest had arisen.

Reess, Zopf, and Brefeld had shown that many higher fungi can assume a yeast-like stage of development if submerged in fluids. Various species of *Mucor*, *Ustilago*, *Exoascus*, and as we now know, numerous Ascomycetes and Basidiomycetes as well, can form budding cells, and it was natural to conclude that probably the yeasts of alcoholic fermentation are merely reduced forms of these higher fungi, which have become habituated to the budding condition—a conclusion apparently supported by Hansen's own discovery that a true *Saccharomyces* can develop a feeble but unmistakable mycelium.

With many ups and downs this question has been debated, but as yet we do not know that the yeasts of alcoholic fermentations can be developed from higher fungi.

During the last two years it appeared as if the question would be settled. Takamine stated that the *Aspergillus* used by the Japanese in brewing saké from rice develops yeast-like cells which ferment the sugar derived from the rice. Jühler and Jorgensen then extended these researches and claimed to have found yeast-cells on other forms of fungi on the surface of fruits, and to have established that they develop endogenous spores—an indispensable character in the modern definition of the genus *Saccharomyces*—and cause alcoholic fermentation.

Klöcker and Schiönning have this last year published the results of their very ingenious and thorough experimental inquiry into this question, and find, partly by pure cultures of the separate forms, and partly by means of excellently devised cultures on ripening fruits still attached to the plant, but imprisoned in sterilised glass vessels, that the yeasts and the moulds are separate forms, not genetically connected, but merely associated in nature, as are so many other forms of yeasts, bacteria and moulds.

It is interesting to notice how here, as elsewhere, the lessons taught by pure cultures are found to bear fruit, and how Hansen's work justifies the specialist's laboratory.

Among the most astonishing results that have come to us from such researches are Hansen's discoveries that several of the yeasts furnish quite distinct races or varieties in different breweries in various parts of the world, and it seems impossible to avoid the conclusion that their race characteristics have been impressed on the cells by the continued action of the conditions of culture to which they have so long been exposed—they are, in fact, domestic races.

Much work is now being done on the action of the environment on yeasts, and several interesting results have been obtained. One of the most striking examples is the fact observed by Sauer, who found that a given variety of yeast, whose activity is normally inhibited when the alcohol attains a certain degree of concentration in the liquid, can be induced to go on fermenting until a considerably higher proportion of alcohol is formed if a certain lactic-acid bacterium is added to the fermenting liquor. The bacterium, in fact, prepares the way for the yeast. Experiments have shown that much damage may be done to beers and wines by foreign or weed germs gaining access with the yeasts, and Hansen has proved that several yeasts are inimical to the action of the required fermentation. But not all pure fermentations give the desired results: partly because the race-varieties of even the approved yeasts differ in their action, and partly, as it appears, on account of causes as yet unknown.

There are facts which lead to the suspicion that the search for the best possible variety of yeast may not yield the desired results, if this particular form is used as a pure culture. The researches of Hansen, Rothenbach, Delbrück, Van Laer, and others, suggest that associated yeasts may ferment better than any single yeast cultivated pure, and cases are cited where such a symbiotic union of two yeasts of high fermenting power has given better results than either alone.

If these statements are confirmed, they enhance the theoretical importance of some investigations I had made several years previously. English ginger-beer contains a curious symbiotic association of two organisms—a true yeast and a true bacterium—so closely united that the yeast-cells imprisoned in the gelatinous meshes of the bacterium remind one of the gonidia of a lichen entangled in the hyphæ of the fungus, except that there is no chlorophyll. Now it is a singular fact that this symbiotic union of yeast and bacterium ferments the saccharine liquid far more energetically than does either yeast or bacterium alone, and results in a different product, large quantities of lactic and carbonic acids being formed, and little or no alcohol.

In the kephir used in Europe for fermenting milk, we find another symbiotic association of a yeast and a bacterium; indeed, Freudenreich declares that four distinct organisms are here symbiotically active and necessary, a result not confirmed by my as yet incomplete investigation. I know of at least one other case which may turn out to be different from either of the above. Moreover, examples of these symbiotic fermentations are increasing in other directions.

Kosai, Yabe, and others have lately shown that in the fermentations of rice to produce saké, the rice is first acted on by an *Aspergillus*, which converts the starch into sugars, and an associated yeast—hitherto regarded as a yeast-form of the *Aspergillus*, but, as already said, now shown to be a distinct fungus symbiotically associated with it—then ferments the sugar, and other similar cases are on record.

Starting from the demonstrated fact that the constitution of the medium profoundly affects the physiological action of the fungus, there can be nothing surprising in the discovery that the fungus is more active in a medium which has been favourably altered by an associated organism, whether the latter aids the fungus by directly altering the medium, or by ridding it of products of excretion, or by adding some gas or other body. This granted, it is not difficult to see that natural selection will aid in the perpetuation of the symbiosis, and in cases like that of the ginger-beer plant it is extremely difficult to get the two organisms apart, reminding us of the similar difficulty in the case of the soredia of Lichens. Moreover, experiments show that the question of relative abundance of each constituent affects the matter.

I must now return for a moment to Buchner's discovery that by means of extremely great pressures a something can be expressed from yeast which at once decomposes sugar into alcohol and carbon-dioxide, and concerning which Dr. Green will inform us more fully. This something is regarded by Buchner as a sort of incomplete protoplasm—a body composed of proteid, and in a structural condition somewhere between that of true soluble enzymes like invertin and complete living protoplasm.

If this is true, and Buchner's *zymase* turns out to be a really soluble enzyme, the present theory of alcoholic fermentation will have to be modified, and a reversion made towards Traube's views of 1858, a reversion for which we are in a measure prepared by Miquel's proof in 1890 that *Urase*, a similar body extracted from the urea-bacteria, is the agent in the fermentation of urea. At present, however, we are not sufficiently assured that the body extracted by Buchner is really soluble, and I am told that very serious difficulties still face us as to what solution is. The enormous pressures required, and the fact that the "solution" coagulates as a whole, might suggest that he was dealing with expressed protoplasm, still alive, but devoid of its cell-wall; against this, however, must be urged the facts that the "solution" can be forced through porcelain and still act, and this even in the presence of chloroform.

We may fairly expect that the further investigation of Buchner's "zymase," Miquel's "urase," and the similar body obtained by E. Fischer and Lindner from *Monilia candida* will help in deciding the question as to the emulsion theory of protoplasm itself.

In any case, soluble or not, these enzymes are probably to be regarded as bits off the protoplasm, as it were, and so the essentials of the theory of fermentation remain, the immediate machinery being not that of protoplasm itself, but of something made by or broken off from it. Enzymes, or similar bodies,

are now known to be very common in plants, and the suspicion that fungi do much of their work with their aid is abundantly confirmed.

Payen and Persoz discovered diastase in malt extract in 1833, and in 1836 Schwann discovered peptase in the juices of the animal stomach. Since that time several other enzymes have been found in both plants and animals, and the methods for extracting them and for estimating their actions have been much improved, a province in which Horace Brown, Green, and Vines have contributed results.

It seems not improbable that there exists a whole series of these enzymes which have the power of carrying over oxygen to other bodies, and so bringing about oxidations of a peculiar character. These curious bodies were first observed owing to studies on the changes which wine and plant juices undergo when exposed to the action of the oxygen of the air.

In the case of the wine certain changes in the colour and taste were traced to conditions which involved the assumption that some body, not a living organism, acts as an oxygen-carrier, and the activity of which could be destroyed by heating and antiseptics. It was found that similar changes in colour and taste could be artificially produced by the action of ozone, or by passing an electric current through the new wine; indeed, it is alleged that the ageing of wine can be successfully imitated by these devices, and is actually a commercial process.

The browning of cut or broken apples is now shown to be due to the action of a similar oxydase—*i.e.* an oxygen-carrying ferment, and the same is claimed for the deep-colouring of certain lacks, or lackers, obtained from the juice of plants such as the *Anacardiaceæ*, which are pale and transparent when fresh drawn, but gradually darken in colour on exposure to air. Bertrand found in these juices an oxydase, which he terms *laccase*, and which affects the oxygen-carrying, and converts the pale fluid juice to a hard dark brown varnish.

Other oxydases have been isolated from beets, *dahlia*, potato-tubers, and several other plants.

These discoveries led Bourquelot and Bertrand in 1895 to the explanation of a phenomenon long known to botanists, and partly explained by Schönbein as far back as 1868. If certain Fungi (e.g. *Boletus luridus*) are broken or bruised, the yellow or white flesh at once turns blue: the action is now traced to the presence in the cell-sap of an oxydase, the existence of which had been suspected but not proved, and the observers named assert that many fungi (59 out of 107 species examined) contain such oxydases.

It will be interesting to see how far future investigations support or refute the suggestion that many of the colour-changes in diseased tissues of plants attacked by fungi are due to the action of such oxydases.

Wortmann, in 1882, showed that bacteria, which are capable of secreting diastase, can be made to desist from secreting this enzyme if a sufficient supply of sugar be given them, and since then several instances have been discovered where fungi and bacteria show changes in their enzyme actions according to the nature of their food supply. Nor is this confined to fungi. Brown and Morris, in 1892, gave evidence for the same in the seedlings of grasses: as the sugar increased, the production of diastase diminished.

It is the diastatic activity of *Aspergillus* which is utilised in the making of saké from rice in Japan, and in the preparation of soy from the soja-bean in the same country, and a patented process for obtaining diastase by this means exists; and Katz has recently tested the diastatic activity of this fungus, of *Penicillium*, and of *Bacterium magatherium* in the presence of large and small quantities of sugar. All three organisms are able to produce not only diastase, but also other enzymes, and the author named has shown that as the sugar accumulates the diastase formed diminishes, whereas the accumulation of other carbo-hydrates produces no such effect.

Hartig's beautiful work on the destruction of timber by fungi obtains new interest from Bourquelot's discovery of an emulsion-like enzyme in many such wood-destroying forms. This enzyme splits the Glucosides, Amygdalin, Salicin, Coniferin, &c., into sugars and other bodies, and the hyphæ feed on the carbo-hydrates. I purpose to recur to this subject in a communication to this Section. The fact that *Aspergillus* can form invertins of the sucrase, maltase, and trehalase types, as well as emulsin, inulase, diastase, or trypsin, according to circumstances of nutrition, will explain why this fungus can grow on almost any organic substratum it alights on, and other examples of the same kind are now coming to hand.

The secretion of special enzymes by fungi has a peculiar interest just now, for recent investigations promise to bring us much nearer to an understanding of the phenomena of parasitism than we could hope to attain a few years ago.

De Bary long ago pointed out that when the infecting germinal tube of a fungus enters a plant-cell, two phenomena must be taken into account, the penetration of the cell-walls and tissues, and the attraction which causes the tips of the growing hypha to face and penetrate these obstacles, instead of gliding over them in the lines of apparent least resistance.

The further development of these two themes has been steady and unobtrusive, and from various quite unexpected directions more light has been obtained, so that we are now in a position to see pretty clearly what are the principal factors involved in the successful attack of a parasitic plant on its victim or "host." That fungi can excrete cellulose-dissolving enzymes is now well known, and that they can produce enzymes which destroy lignin must be inferred from the solution of wood-cells and other lignified elements by tree-destroying fungi. Zopf has collected several examples of fungi which consume fats, and further cases are cited by Schmidt, by Ritthausen, and Baumann. In these cases also there can be no doubt that an enzyme or similar body is concerned.

There is one connection in which recent observations on enzymes in the plant-cell promise to be of importance in explaining the remarkable destructive action of certain rays of the solar-light on bacteria. As you are aware, the English observers Downes and Blunt showed long ago that if bacteria in a nutrient liquid are exposed to sunlight, they are rapidly killed. Further researches, in which I have had some part, gradually brought out the facts that it is really the light rays and not high temperatures which exert this bactericidal action, and by means of a powerful spectrum and apparatus furnished by the kindness of Prof. Oliver Lodge I was able to obtain conclusive proof that it is especially the blue-violet and ultra-violet rays which are most effective. This proof depended on the production of actual photographs in bacteria of the spectrum itself. Apart from this, I had also demonstrated that just such spores as those of anthrax, at the same time pathogenic and highly resistent to heat, succumb readily to the action of these cold light-rays, and that under conditions which preclude their being poisoned by a liquid bathing them.

The work of Brown and Morris on the daily variations of diastatic enzyme in living leaves, and especially Green's recent work on the destructive action of light on this enzyme, point to the probability that it is the destruction of the enzymes with which the bacterial cells abound which brings about the death of the cell.

That these matters are of importance in limiting the life o. bacteria in our streets and rivers, and that the sun is our most powerful scavenger, has been shown by others as well as myself. In this connection may also be mentioned Martinand's observations, that the yeasts necessary for wine-making are deficient in numbers and power on grapes exposed to intense light, and he explains the better results in Central France as contrasted with those in the South as largely due to this fact. Whether, or how far, the curious effects of too intense illumination in high latitudes and altitudes on plants which might be expected to grow normally there, can be explained by a destructive light action on the enzyme of the leaves, has not, so far as I know, been tested; but Green's experiments certainly seem to me to point to the possibility of this, as do the previous experiments with screens of Pick, Johow, myself, and others.

It is interesting to note that Wittlin and others have confirmed the conclusion my own few trials with Röntgen rays led to; they show no action whatever.

That branch of mycology which is now looked upon by so many as a separate department of science, usually termed bacteriology, only took shape in the years 1875-79, when its founder, the veteran botanist Cohn, who recognised that the protoplasm of plants corresponded to the animal sarcode, and who has been recently honoured by our Royal Society, published his exact studies of these minute organisms, and prepared the way for the specialists who followed.

It is quite true that isolated studies and observations on bacteria had been made from time to time by earlier workers than Cohn, though it is usually overlooked that Cohn's first paper on Bacteria was published in 1853. Ehrenberg in

particular had paid special attention to some forms; but neither he nor his successors can be regarded as having founded a school as Cohn did, and this botanist may fitly be looked upon as the father of bacteriology, the branch of mycology which has since obtained so much diversity.

It should not be overlooked that the first proof that a specific disease of the higher animals is due to a bacillus, contained in Koch's paper on Anthrax, was published under Cohn's auspices and in his "Beiträge zur Biologie der Pflanzen" in 1876, four years after Schroeter's work from the same laboratory on pigmented bacteria, and that the plate illustrating Koch's paper was in part drawn by Cohn.

It is of primary importance to recognise this detail of Koch's training under Cohn, because, as I have shown at length elsewhere, popular misapprehensions as to what bacteriology really consists in have been due to the gradual specialisation into three or four different schools or camps of a study which is primarily a branch of botany; and, again, it is of importance to observe that the whole of this particular branch of mycology, to which special laboratories and an enormous literature are now devoted, has arisen during the last quarter of a century, and subsequent to the foundation of scientific mycology by De Bary. When we reflect that the nature of parasitic fungi, the actual demonstration of infection by a fungus spore, the transmission of germs by water and air, the meaning and significance of polymorphism, heterœcism, symbiosis, had already been rendered clear in the case of fungi, and that it was by these and studies in fermentation and in the life-history of the fungus *Saccharomyces* that the way was prepared for the ætiology of bacterial diseases in animals, there should be no doubt as to the mutual bearings of these matters.

Curiously enough, it was an accident which deflected bacteriology along lines which have proved so significant for the study of this particular group of minute organisms, that an uninitiated visitor to a modern bacteriological laboratory (which in England, at any rate, is usually attached to the pathological department of a medical school) hardly perceives that he is in a place where the culture of microscopic plants is the chief object—for the primary occupation of a bacteriologist is really, after all, the cultivation of minute organisms by the method of "microscopic gardening," invented by De Bary, Klebs, and Brefeld, whether the medium of culture is a nutritive solution, or solid organic substrata like potato, agar, or gelatine, or the tissues of an animal.

This accident—I use the word in no disrespectful sense—was Koch's ingenious modification of the use of gelatine as a medium in which to grow bacteria: he hit upon the method of pouring melted gelatine containing distributed germs on to plates, and thus isolating the colonies.

Pasteur and Cohn had already coped with the difficulty of isolating mixed forms by growing them in special fluids. When a given fluid favoured one form particularly, a small quantity containing this predominant species was put into another flask of the fluid, then a drop from this flask transferred to a third flask, and so on, until the last flasks contained only the successful species, the others having been suppressed: these "fractional cultures" were brought to a high state of perfection by the botanist Klebs in 1873.

Then Brefeld (1872) introduced the method of dilution—*i.e.* he diluted the liquid containing his spores until each single drop taken contained on the average one spore or none, whence each flask of sterile nutritive solution receiving one drop contained either none or *one* spore. Brefeld was working with fungi, but Lister—now Lord Lister, and our late President—applied this "dilution method" to his studies of the lactic fermentation in 1878, and Naegeli, Miquel, and Duclaux carried it further, the two latter especially having been its chief defenders, and Miquel having employed it up to quite recently.

Solid media appear to have been first generally used by Schroeter in 1870, when he employed potatoes, cooked and raw, egg-albumen, starch-paste, flesh, &c. Gelatine, which seems to have been first employed by Vittadini in 1852, was certainly used by Brefeld as early as 1874, and even to-day his admirable lecture on "Methoden zur Untersuchung der Pilze" of that date is well worth reading, if only to see how cleverly he obtains a single spore isolated in gelatine under the microscope. Klebs used gelatine methods in 1873.

We thus see that when Koch proposed his method of preparing gelatine plate-cultures in 1881 he instituted, not a new culture-medium, for cultures on solid media, including gelatine, had been in use by botanists for eight or ten years; nor did he introduce methods for the isolation of spores, for this had been done long before. What he really did was to ensure the isolation of the spores and colonies wholesale, and so facilitate the preparation of pure cultures on a large scale, and with great saving of time.

It was a brilliant idea, and, as has been said, "the Columbus egg of Bacteriology"; but we must not lose sight of the fact that it turned the current of investigation of bacteria from the solid and trustworthy ground established by Cohn, Brefeld, and De Bary, into a totally new channel, as yet untried.

We must remember that De Bary and Brefeld had aimed at obtaining a single spore, isolated under the microscope, and tracing its behaviour from germination, continuously to the production of spores again; and when we learn how serious were the errors into which the earlier investigators of the mould-fungi and yeasts fell, owing to their failure to trace the development continuously from spore to spore, and the triumphs obtained afterwards by the methods of pure cultures, it is not difficult to see how inconclusive and dangerous all inferences as to the morphology of such minute organisms as bacteria must be unless the plant has been so observed.

As matter of fact, the introduction and gradual specialisation of Koch's methods of rapid isolation of colonies encouraged the very dangers they were primarily intended to avoid. It was soon discovered that pure cultures could be obtained so readily that the characteristic differences of the colonies in the mass could presumably be made use of for diagnostic purposes, and a school of bacteriologists arose who no longer thought it necessary to patiently follow the behaviour of the single spore or bacillus under the microscope, but regarded it as sufficient to describe the form, colour, markings, and physiological changes of the bacterial colonies themselves on and in different media, and were content to remove specimens occasionally, dry and stain them, and describe their forms and sizes as they appeared under these conditions.

To the botanist, and from the points of view of scientific morphology, this mode of procedure may be compared to what would happen if we were to frame our notions of species of oak or beech according to their behaviour in pure forests, or of a grass or clover according to the appearance of the fields and prairies composed more or less entirely of it, or—and this is a more apt comparison, because we can obtain colonies as pure as those of the bacteriologist—of a mould-fungus according to the shape, size, and colour, &c., of the patches which grow on bread, jam, gelatine, and so forth.

Now it is obvious that this is abandoning the methods of morphology, and the consequence has been that two schools of descriptive bacteriologists are working along different lines, and the "species" of the one—the test-tube school—cannot be compared with those of the other, the advocates of continuous culture from the spore.

The difficulty of isolating a bacterium and tracing its whole life-history under the microscope is so great, that the happy pioneers into the fascinating region opened up by the test-tube methods may certainly claim considerable sympathy in their cry that they cannot wait. Of course they cannot wait; no amount of argument will prevent the continual description of new test-tube "species," and all we can do is to go on building up the edifice already founded by the botanists Cohn, Brefeld, De Bary, Van Tieghem, Zopf, Prazmowski, Beyerinck, Fischer, and others who have made special studies of bacteria.

The objection that such work is slow and difficult has no more weight here than in any other department of science, and in any case the test-tube school is already in the plight of being frequently unable to recognise its own "species," as I have convinced myself by a long-continued series of cultures with the object of naming common bacteria.

I wish to guard myself against misconstruction in one particular here. It is not insinuated that the test-tube methods and results are of no value. Far from it; a vast amount of preliminary information is obtained by it; but I would insist upon the discouragement of all attempts to make "species" without microscopic culture; and continuous observation of the development as far as it can be traced.

The close connection between bacteriology and medicine has been mainly responsible for the present condition of affairs; but it is high time we recognised that bacteriology only touches animal pathology at a few points, and that the public learn that, so far from bacteria being synonymous with disease germs, the

majority of these organisms appear to be beneficial rather than inimical to man. There is not time to attempt even a brief description of all the "useful fermentations" due to bacteria, but the following cases will point the conviction that a school of bacteriology, which has nothing to do with medical questions, but investigates problems raised by the forester, agriculturist, and gardener, the dairyman, brewer, dyer, and tanner, &c., will yet be established in England in connection with one or other of our great botanical centres.

(To be continued.)

PHYSICS AT THE BRITISH ASSOCIATION.

THE meeting of the American Association at Detroit and the central position of Toronto have contributed greatly in bringing together a large number of Canadian and American mathematicians and physicists to meet their co-workers on this side of the Atlantic. The opportunity thus afforded of conference and exchange of ideas has been one of the chief pleasures of the meeting.

It was universally felt that the presidential address of Prof. Forsyth (pp. 374–378) formed a clear and eloquent exposition of the claims of pure mathematics, and at its close Lord Kelvin, in moving a vote of thanks, declared that any one in science who could possibly choose would elect to belong to the mathematical rather than the non-mathematical class. President London, of the Toronto University, in seconding the vote, said that the address was specially needed in Toronto, because the public there had accused the university of attaching too much importance to mathematics.

Mr. J. A. Paterson, in a paper on the unification of time, described the efforts made by several scientific societies in Canada to secure uniformity in the specification of time by astronomers, navigators and the public; the suggestion being that the day should commence and end at midnight, and the hours be counted from 0 to 24. The proposal gave rise to some discussion. Prof. Newcomb pointed out that navigators, making observations usually at noon, found that time most convenient as the commencement of the day, while astronomers for similar reasons would choose midnight. Prof. Rücker gave an account of the inquiries made by the British Royal Society, Foreign Office and Admiralty, from which it appears that any international agreement is at present hopeless; so that the Nautical Almanac for 1901 will be compiled in the same manner as its predecessors.

Prof. Rücker exhibited photographic records of objective combination tones, both summational and difference tones having been obtained. In this research he was assisted by Messrs. Forsyth and Sowter. The method and apparatus used were the same as in the investigation of Prof. Rücker and Mr. Edser—namely, the observation of interference bands produced by the light reflected from a mirror carried by a resonant tuning-fork; the shift of the bands by the motion of the fork was, however, photographed on a moving sensitive surface, instead of being observed by eye.

An account of the work of the Committee on Seismological Observations was given by its indefatigable secretary, Prof. Milne. An examination of earthquake records seems to show that sub-oceanic earthquakes and landslips are more frequent than those on land, and that the Tuscarora deep is the origin of many of them. The most important portion of the report is, however, that relating to the rate of propagation of seismic waves from their origin to various points on the earth's surface. The records show that the velocity of propagation increases with the distance travelled, so that most probably the wave goes through the earth and not round its superficial crust, the speed of transmission being greater in the interior than in the crust. This, as Lord Kelvin pointed out, indicates that the moduli of elasticity of the material of the earth's interior are greater than those of the crust, possibly because of the higher pressure at great depths.

At the meeting of the section on Friday, Dr. N. E. Dorsey described some careful experiments to determine the surface tension of water by the method of ripples, the results of which agree with those of M. Sentis, obtained by an entirely different method. In the case of dilute aqueous solutions, the surface tension obtained by this method is a linear function of the concentration.

Prof. Callendar and Mr. Barnes gave an account of their new method of measuring the specific heat of liquid, by passing an electric current through a fine tube through which a current of the liquid flows. The experiment is continued until the temperature-difference between the ends of the tube becomes steady; this temperature-difference and the rate of flow of the liquid are then measured. Loss of heat by radiation is almost eliminated by surrounding the tube with a vacuous chamber, and small losses are allowed for. Another important communication on calorimetry was that of Profs. Ewing and Dunkerley on the specific heat of superheated steam. Their method consists in passing saturated steam through a porous plug, thus superheating it; the results show that for 10° superheating at atmospheric pressure the specific heat is about 0·44, while the ordinarily accepted value, 0·48, is only correct if the superheating exceeds 25°, as in Regnault's experiments.

A crowded audience assembled to hear Lord Kelvin's paper on the fuel-supply and air-supply of the world. He argued that, as the earth was in all probability originally hot and liquid, no primeval vegetable fuel existed; further, no free oxygen existed at that period, since it is not found in gases evolved from minerals or in the spectra of stars. Probably, therefore, the oxygen of the air has resulted from the action of sunlight on plants, and as this oxygen would be furnished by 340 million million tons of fuel, we have an upper limit to the amount of fuel in the world. On the other hand, the British Coal Supply Commission of 1831 estimated the amount of available fuel in England and Scotland to be 146,000 million tons, which is greater than the average for the whole earth. It follows, then, that the oxygen of the atmosphere resting over Britain is insufficient to burn up the fuel of the country, and the cessation of life may possibly occur by asphyxiation rather than want of fuel. In the discussion on this paper Prof. Fitzgerald stated that, according to his calculations, the sun's energy will support five persons to every square metre, so that there is no fear of life becoming extinct by failure of the sun's energy, as some people have supposed.

In spectroscopy, Prof. Runge stated that Prof. F. Paschen and himself had succeeded in separating the spectrum of oxygen into six series, two principals each having two subordinates, the lines of one principal series and its subordinates being triple. The importance of this paper lies in the fact that the oxygen spectrum is shown to be analogous to that of helium; and as oxygen does not, so far as we know, contain a mixture of elements, the idea that helium is a mixture has now been abandoned. Profs. Runge and Paschen find also that the spectra of sulphur and selenium each give a principal series of lines and two subordinate series, but in each case one line occurs which does not fit into any of the series, and which may be the fundamental line of another series. Using the large grating of the Johns Hopkins University, Mr. W. J. Humphreys has succeeded in causing the lines in the arc spectra of metals to shift appreciably by increasing the pressure of the atmosphere surrounding the arc; in all cases increased pressure causes the wave-length of the lines to increase, the lines move towards the red end of the spectrum. The shift is of the same order of magnitude as the Doppler effect, but could be distinguished from the Doppler effect in a celestial spectrum by the fact that lines belonging to principal and subordinate series are differently shifted by pressure, whereas they are all displaced equally in the spectrum of a receding body. Dr. J. Larmor has discussed the subject mathematically, and finds that the displacement is of the same order as would be produced by change of specific inductive capacity of the air by pressure. Prof. Schuster has photographed a metallic spark-spectrum on a film moving rapidly at right angles to the slit of the spectroscope; the result shows that the air-lines flash out for an exceedingly short time: the metallic particles, however, remain luminescent for a much longer period with gradually diminishing intensity. He was able to trace the motion of the metallic particles from the electrodes to the middle of the spark, and to measure their velocity, which ranged from 400 to 2000 metres per second.

Prof. S. P. Thompson distinguished four varieties of kathode rays, differing in their power of exciting fluorescence, exciting X-rays, and deflexion by a magnet. The first kind is the ordinary kathode ray; the second kind is produced when kathode rays have fallen on a surface and produced X-rays (they have then lost their power of exciting more X-rays). The third variety arises when kathode rays are passed through a negatively charged metallic spiral or gauze-sieve; they cannot be deflected

by a magnet. The fourth kind appears at the openings in a Holtz's funnel-tube; it produces no fluorescence, but can be deflected by a magnet.

A serious state of things was revealed by Prof. A. Johnson in his paper on a Canadian and Imperial Hydrographic Survey. He said that in some parts of the St. Lawrence basin places had been found where the depth of water, charted at five fathoms, was not more than three fathoms, and navigation was thereby rendered dangerous. A committee has been appointed to consider the question of approaching the Canadian Government with reference to a new hydrographic survey.

On Monday the section met in two departments, devoted to mathematics and meteorology respectively. In the mathematical department Dr. Harris Hancock gave a short account of the historical development of Abelian Functions, and the complete paper will be published as one of the reports of the Association. Prof. Henrici proposed a new notation to denote the different products of vectors, which consists in using square brackets for vector products and round brackets for scalar products. He likewise advocated the adoption of Heaviside's term "ort" for a vector, the tensor of which is the number 1. Prof. A. Macfarlane read a communication on the solution of the cubic equation, in which he explained how the two binomials in Cardan's formula may be treated as complex quantities, either circular or hyperbolic; all the roots of the cubic can then be deduced by a general method. Prof. Michelson described some new Harmonic Analyses made by himself and Mr. S. W. Stratton with an instrument which is capable of rendering 80 terms of a Fourier series and of checking the accuracy of its own work. The only limit to the number of terms obtainable is the expense of making the instrument.

In the department of meteorology, Dr. van Rijckevorsel pointed out that the curves of daily temperature for the different meteorological stations in Europe indicate a possible division of the continent into two regions with marked differences of climate. The eastern region includes Russia and adjacent countries, the rest of the continent being in the western region. Small irregularities, such as secondary maxima and minima, are reproduced in all the curves for places in the same region, and serve to show that the temperatures are determined by external causes operating over the whole area. Mr. F. N. Denison described observations on "seiche" movements on Lakes Ontario and Huron, obtained by means of a tidal gauge. Mr. A. L. Rotch reported progress made during the year in the exploration of the air by means of kites. Meteorographs have been raised to a height of 8740 feet above the Blue Hill Observatory, and important information has been obtained concerning humidity, changes of temperature and wind in free air. The value of these results in aiding the forecasting of the weather is so great that the United States Weather Bureau has taken up the subject. Prof. Marvin described his experiments with tail-less kites, and afterwards exhibited one in flight in the University grounds.

In electricity, several forms of apparatus for mapping out the form of an alternate current wave were described and exhibited. In the instrument of Prof. Rosa a contact revolving on the dynamo shaft puts a point in the circuit into contact with a potentiometer at any phase of the revolution. By means of an electro-magnetic ratchet arrangement the contact can be advanced in phase by small equal amounts, and the same current similarly rotates a revolving cylinder on which the length of wire necessary for a balance on the potentiometer is automatically recorded. Mr. Duddell makes use of the force urging a straight conductor carrying a current and stretched in a magnetic field; two parallel phosphor-bronze strips are placed in a strong magnetic field and attached to a mirror, so that when the alternating current goes up one of these strips and down the other one, the mirror is deflected. Prof. Braun uses a kathode ray instead of a strip, and puts it in a magnetic field set up by the alternating current; the ray is thus deflected and follows every pulsation of the current. The source of luminosity in the electric arc has been investigated by Prof. Henry Crew and Mr. O. H. Basquin. They maintain an arc between an iron rod and a rotating iron disc by a rapidly intermittent electric current, and observe the arc in the intervals when no current is passing. It is found that the luminosity is of two kinds, a bright cloud yellow persisting some time and a much fainter and rapidly evanescent blue flame; the spectra of these two portions differ in the distribution of intensity of their lines.

The Electrical Standards Committee report that they have decided to undertake the experiments necessary for the specification of the standard of electric current, which will be conducted by Profs. Ayrton and J. V. Jones.

At Wednesday's sitting, Prof. Ramsay described experiments on the refractivity of mixtures of gases, from which it appears that an expansion takes place on mixing hydrogen and helium, and a contraction on mixing nitrogen and oxygen. Prof. Fitzgerald suggested that the viscosity of mixtures of gases should be more fully examined. Prof. Lodge described Zeeman's discovery of the effects of magnetism on spectral lines, and discussed the nature of the dark space between the two lines into which the originally single band is split. Profs. Lodge, Michelson and Runge were agreed that this space is a part of the Zeeman phenomenon, and is not produced merely by the absorption of light in the region round the flame. Several papers on galvanometry were communicated by Prof. Ayrton and Mr. Mather. In the discussion on papers by Prof. Callendar and Mr. Barnes, and Messrs. Spiers, Twyman and Waters, on Clark cells, it was stated by Prof. Webster, that Clark cells with cadmium electrodes in place of zinc are as trustworthy and easily set up as the older form. Such cells have a much smaller temperature coefficient than zinc-cells.

The meeting concluded with a paper by Mr. J. W. Edmondson, read by Prof. Webster, on spark-length and potential relations in air and dielectric liquids. For air a hyperbolic formula apparently fits the results in the case of spheres of 3 cm. diameter.

A vote of thanks to the President, moved by Prof. Ayrton and seconded by Prof. Lodge, brought the proceedings of the section to a close.

CHEMISTRY AT THE BRITISH ASSOCIATION.

THE meetings of the Chemistry Section were usually well attended throughout the whole of the somewhat protracted sittings at Toronto. A large number of the chemists of Canada and of the United States were present, and added much to the interest of the meeting, both within and without the section room. The section only participated, and that in an informal way, in one united discussion, which took place between Sections I and K on the chemistry and structure of the cell. This was opened by Prof. Meldola in a very striking and suggestive paper on the rationale of chemical synthesis.

In connection with the section an important new committee has been appointed, under the chairmanship of Sir John Evans, for the promotion of agriculture, its object being to report on the methods and results of the Government Agricultural Stations in Canada and other countries, with a view to the establishment of similar institutions in Great Britain. As an unusually large number of papers were read, only those of the most general interest can be here mentioned.

Prof. Ramsay followed up his address, which was none the less interesting because of its speculative character, by an account of the methods employed in the work on helium and in the determination of the remarkable properties by which that gas is characterised. He expressed the opinion that helium is occluded, and not definitely combined in the various minerals in which it occurs. A short communication was also read, in which it was pointed out by Mr. M. Travers that the hydrogen obtained by heating many igneous rocks *in vacuo* is in reality derived from water which is present, and is reduced by various substances, such as ferrous oxide, contained in the material of the rock.

The section devoted a considerable portion of one of its sittings to the consideration of atomic weights, and was fortunate in the attendance of Profs. B. Brauner, F. W. Clarke, E. W. Morley and T. W. Richards, in addition to the home contingent of chemists distinguished in this particular field. Prof. Brauner, resting from his labours on tellurium, has turned his attention to thorium, and has succeded in making a satisfactory determination of its atomic weight by the oxidation of the double ammonium oxalate. The number which he has obtained is 232·5 (O = 16), and is considerably lower than Cleve's number. Prof. Richards has attacked the problem of the atomic weights of nickel and cobalt, about which great uncertainty has hitherto prevailed, and has analysed the very carefully dried and purified bromides of these metals. The separate determinations agree admirably among themselves, and it seems probable that the

values Ni = 58·69, and Co = 58·99 will take their places as standards among the numerous other results, which have been obtained in such rapid succession in the laboratory of Harvard.

One of the most attractive items on the programme of the section was the demonstration of the preparation and properties of fluorine, by Prof. E. Meslans. Since the Nottingham meeting, at which the demonstration was made for the first time in England, an important simplification has been introduced into the apparatus required for the production of the gas, which will probably render it possible to include the preparation of this element in the ordinary course of lecture experiments, and may even lead to its economical production on the large scale, should any industrial application of the gas be found desirable. The latest form of apparatus consists entirely of copper, and is larger than the costly platinum apparatus of Moissan, although the same general shape is preserved. The apparatus is charged in the usual way, and is then itself connected with the positive terminal of a battery, the two eleectrodes being made the negative pole. Fluorine is thus evolved at the internal surface of the apparatus, and a thin non-conducting layer of copper fluoride is deposited upon it. The apparatus after this preliminary treatment is employed exactly in the same way as Moissan's platinum apparatus, but may be simply cooled by ice and salt. The presence of the non-conducting layer of copper fluoride prevents the passage of electricity from the electrode to the side of the vessel, and thus avoids the consequent loss of fluorine; so that the yield in the new modification of the apparatus is much greater than in the original form.

Several papers on subjects connected with physical chemistry were contributed. The first of these was read by Prof. H. B. Dixon, in continuation of his previous work on explosions of gases, and dealt with the curious phenomena attending the commencement of an explosion in a gaseous medium, which may be investigated by photographing the flash. If the mixture be fired at the end of a tube, the disturbance very gradually increases in velocity as it passes along the tube, until after a comparatively great distance has been traversed, the velocity characteristic of the mixture is reached. When, however, the firing-point is 3 or 4 inches from the end of the tube, the disturbance passing slowly down the longer portion of the tube is reinforced by the wave which has traversed the short distance to the end of the tube, and has there been reflected. After this reinforcement, the united disturbances travel at a much more rapid rate, and the maximum velocity is quickly attained. Another investigation on the mechanism of a reaction, but from a different point of view, was described by Dr. J. W. Walker in a paper dealing with the reaction between hydrobromic and bromic acids in aqueous solutions. Time measurements of the rate of liberation of bromine show that most probably the reaction does not take place between six molecules as indicated in the ordinary equation, but between two. It is therefore probable that the reduction of the bromic acid takes place in stages, bromous and hypobromous acids being probably formed as intermediate products. Dr. W. L. Miller, of Toronto University, in a paper on the vapour tensions of mixed liquids, explained the method adopted by himself and Mr. Rosebrough for testing the validity of Gibb's equation for the equilibrium of the vapours of mixtures of liquids at constant temperatures, and demonstrated that actual determinations of the composition of the vapour given off from various mixtures of alcohol and water agree very closely with the calculated numbers. The Röntgen rays again formed the subject of an investigation at the hands of Dr. J. H. Gladstone and Mr. W. Hibbert, who have compared the absorptive power of various salts of the same metal (lithium), and have thus obtained relative values for the various acid radicals.

A number of short papers on organic chemistry were communicated to the section, including a review by Prof. P. C. Fuer, of his work on the constitution of acetone and other analogous ketones; the formation of a benzene ring by the reduction of a 1–6-di-ketone, by Dr. A. Lehmann; condensation products of aldehydes and amides, by Dr. C. A. Kohn; and on the nitro-alcohols, by Prof. L. Hemy, of Louvain. Great interest was excited by a very able paper on the chemistry of methylene, by Prof. J. V. Nef, of Chicago, in which the latest results obtained in the study of compounds containing dyad-carbon were described. Prof. Nef has obtained a very unstable series of substances which he regards as acetylidene derivatives, $CR_2 = C$, isomeric with the normal acetylene derivatives $RC \equiv CR$. The di-iodo-compound is the most stable, but even this slowly burns when exposed to the air, whilst the other derivatives undergo a much more rapid combustion under the same circumstances. All the compounds are violently poisonous. The di-iodo-derivative can be prepared in a number of different ways, the most interesting of which are (1) the direct action of sunlight on tetra-iodo-ethylene, $I_2C = CI_2$, one molecule of iodine being liberated; and (2) the action of iodine on silver acetylene. On oxidation it appears to primarily yield carbonic oxide and iodine, but the latter converts a portion of the unaltered compound into tetra-iodo-ethylene. The monobromo-derivative bears in its properties a most remarkable resemblance to phosphorus, and is termed by its discoverer "vegetable phosphorus," since it shines in the dark, burns on exposure to the air, and acts as a violent poison, in the same way as phosphorus.

Several papers dealing with local problems were presented by various chemists. The most elaborate of these was a very extensive series of analyses of the virgin soils of Canada, submitted by Dr. F. T. Shutt, who occupies the important position of chemist to the Dominion Experimental Farm at Ottawa. These showed that some of the prairie soils of Manitoba are of extraordinary richness and fertility, whilst the soils of Canada in general may be considered as of a satisfactory character for agricultural purposes. Some interesting analyses of coal from the pre-carboniferous rocks of Canada were communicated by Prof. Ellis, of Toronto. These showed in a very striking way the gradual transition from petroleum and its immediate product of decomposition, asphalt, to anthracite and pure carbon. Prof. Roberts-Austen showed a number of interesting slides, which supplemented the information given in his evening lecture on the metals of Canada, as to the close similarity of the phenomena exhibited by ordinary liquids, and metals in the molten, and even in the solid form. Mr. Ramage also exhibited a series of slides, reproduced from photographs of the spectra of various metals and minerals in the oxyhydrogen flame, showing the presence of many unsuspected constituents in very small amounts.

Great interest was shown in a demonstration by Prof. Andrews, of the plaster of Paris method in blowpipe work. In this method charcoal is replaced by a thin, oblong tablet made of plaster of Paris, mixed with a little boric acid. This can be employed for all the ordinary tests which are conducted on charcoal or platinum wire. Prof. Andrews has, moreover, elaborated a series of extremely delicate and characteristic tests for a large number of metals, which depend on the coloured films produced when compounds of these metals are treated with a solution of iodine in potassium thiocyanate. These consist partly of oxide and sulphide, partly of iodide and oxyiodide, and are very brilliant in colour. Although not so suitable for teaching purposes, these iodide films afford a very ready method for the detection of the constituents of a metal in the field, and will no doubt be welcomed by practical mineralogists.

An interesting, though somewhat speculative, attempt was made by Mr. L. T. Addison to refer the different crystalline forms and specific gravities of the allotropic forms of many of the elements to different modes of arrangement of the same primal forms, the shape of which is intimately connected with the valency of the element.

A break in the routine of business was enjoyed by the members of the section on Saturday, when a visit was paid to the electric power-house at Niagara, and the works for the production of carborundum and of soda by the electrolytic process, which are in its immediate neighbourhood, and derive their energy from the diverted waters of the Fall.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. JULIUS HANN, Director of the Vienna College of Meteorology, has been appointed professor of meteorology at Gratz, in Styria. Prof. Joseph Pernter, professor of cosmical physics in Innsbruck University, has been appointed to the vacancy caused by Dr. Hann's retirement from the Vienna College. Dr. E. von Esmarch, assistant professor of hygiene at Königsberg, has been made full professor. Mr. William Saunders, second master at the Cardigan Intermediate School, has been appointed head master of the Radnorshire County School at Llandrindod Wells.

IN an address delivered before the British Medical Association at the meeting in Montreal last week, Dr. T. G. Roddick, the President of the Association, gave a description of the condition of medical education in Canada. He showed that laboratory methods prevail in the medical schools of the Dominion, all with the idea of developing the scientific spirit in students, and of cultivating methods of thought with observation. Referring to the value of a preliminary science course, he said that the late Prof. Huxley thought it was a most self-evident proposition that the educational training for persons who proposed to enter the medical profession should be largely scientific; not merely or even principally because an acquaintance with the elements of physical and biological science is absolutely essential to the comprehension of human physiology and pathology, but still more because of the value of the discipline afforded by practical work in these departments in the process of observation and experiment, in inductive reasoning, and in manipulation.

EDUCATION in science is not obtained by reading, but by personal observation and experience. It is possible, however, to create and stimulate an interest in natural knowledge by means of books wisely selected and used. This is what the National Home Reading Union aims at doing. The work of the Union is mainly concerned with literature and human history, but it also includes natural history. During the session 1897-98, shortly to commence, a course of reading in elementary botany will be taken. The session is not a favourable time for the study of flowering plants, but flowerless plants can be studied as well in the winter as in the summer. Among the latter plants especial weight will be given in the course to those forms of fungi and algæ which have been recently shown to play so large a *rôle* in the preparation of soil, in the ripening of cheese, and in other industrial processes, as well as in the causation of disease in plants and animals. The course will thus not only draw attention to interesting forms of plant life, but will also be of assistance in understanding the nature of bacteria. We presume that the students who take up the course are recommended to obtain a small microscope, and are instructed how to use it in the observation of the organisms described.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 30.—M. A. Chatin in the chair.—On the hypocycloid of Steiner, by M. Paul Serret.—On plasmolysis, by M. Mouton.—Photography of fluoroscopic images, by M. Charles Porcher.—*Pseudocommis vitis* (Debray), a parasite of marine plants, by M. E. Roze.

NEW SOUTH WALES.

Linnean Society, July 28.—Prof. J. T. Wilson, President, n the chair.—On the occurrence of the genus *Palæchinus* in the Upper Silurian rocks of New South Wales, by John Mitchell. The author described and figured a fragmentary specimen comprising the middle portion of an interambulacral area showing four rows of plates, from the Middle Trilobite Bed, Bowning Village, N.S.W.—Two ornate boomerangs from North Queensland, by R. Etheridge, junr.—New Australian lepidoptera, by Oswald B. Lower. Eighteen species, chiefly referable to the *Œcophoridæ* and *Gelechiadæ*, are described as new.—On the Cinnamomums of New South Wales: with a special research on the oil of *C. Oliveri*, Bailey, by R. T. Baker. The genus *Cinnamomum*, hitherto unrecorded for New South Wales, is now shown to occur over a large area of the coastal district, being represented by two species, *C. Oliveri*, Bailey, and *C. virens*, sp. nov. The former species has in the past been mistaken in the northern colony for *Beilshmiedia obtusifolia*, and has only recently been identified as a *Cinnamomum*; very probably the same confusion of species has occurred in New South Wales. *C. virens* appears to stand somewhat alone, its affinities with known species not being very marked. Descriptions of the timber, gall-fungus, bark and oil are given. The oil obtained from *C. Oliveri* is highly aromatic, and is found to contain cinnamic aldehyde, eugenol, together with other constituents. The bark gave nearly 1 per cent. of oil. It is hoped that a new commercial product may result from these investigations.—On the Rhopalocera of Lord Howe Island, by G. A. Waterhouse. The late Mr. A. S. Olliff enumerated ten species as occurring on the island ["Lord Howe Island," &c. Memoirs of Australian Museum. No. ii. p. 98, 1889]. The number is now increased to eighteen species, of which eight were not previously recorded. All the species are known to occur on the Australian continent.—Stray notes on Papuan ethnology, part ii., by C. Hedley. Two articles from New Guinea are described: (*a*) A gigantic fish hook, 19 inches long, usually miscalled a shark hook, brought from Milne Bay by Mr. N. Hardy. Recent researches in the Ellice Islands indicate that this is employed to catch a deep-sea fish there called "Palu"; possibly an unknown species of the *Macruridæ*. The present hook differs from any hitherto known by a mounting of wicker work for the attachment of the fishing line. (*b*) An intricate knot used by the women of East New Guinea in making the grass petticoat; and attention is drawn to the value of such a detail in tracing the migration or descent of races.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The New Psychology: Dr. E. W. Scripture (Scott)—Leghe Metalliche ed Amalgame: I. Ghersi (Milano, Hoepli).—La Fabricazioni dell' Acido Solforico: Dr. V. Vender (Milano, Hoepli).—Manuale del Chimico e dell' Industriale: Prof. L. Gabba (Milano, Hoepli).—Philosophy of Knowledge: Prof. G. T. Ladd (Longmans).—Laboratory Practice for Beginners in Botany: Prof. W. A. Setchell (Macmillan).—Natural Elementary Geography: J. W. Redway (New York, American Book Company).—Chart of the World: Dr. H. Berghaus, xii. edition (Gotha, Perthes).

PAMPHLETS.—A Critical Period in the Development of the Horse: Prof. J. C. Ewart (Black).—Archeological Studies among the Ancient Cities of Mexico: W. H. Holmes, Part 2 (Chicago).—Observations on Popocatepetl and Ixtaccihuatl: Dr. O. C. Farrington (Chicago).—List of Mammals from Somaliland: D. G. Elliot (Chicago).—Bæveren i Norge dens Udbredelse og Levemaade: R. Collett (Bergen, Griegs Bogtrykkeri).

SERIALS.—Contemporary Review, September (Isbister).—National Review, September (Arnold).—Scribner's Magazine, September (Low).—The Atoll of Funafuti, Part 3 (Sydney).—Fresenius' Quantitative Analysis, translated by C. E. Groves, Vol. 2, Part 5 (Churchill).—The Atlantic Monthly, September (Gay).—The Fortnightly Review, September (Chapman).—Observatory, September (Taylor).—Geographical Journal, September (Stanford).—Journal of the Chemical Society, September (Gurney).—Imperial University, College of Agriculture, Bulletin Vol. iii. Nos. 2 and 3 (Komaba).—Astrophysical Journal, August (Chicago).

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